



**IMHEF**

INSTITUT  
DE MACHINES  
HYDRAULIQUES  
ET DE MÉCANIQUE  
DES FLUIDES

ÉCOLE  
POLYTECHNIQUE  
FÉDÉRALE  
DE LAUSANNE

# **GABRIEL TERRA**

***Ensayos contractuales en modelo  
Informe final***

*Versión 01*

*Sustituido por la versión 02*

***Abril 1992***

Prof. P. HENRY  
Eng. H.-P. MOMBELLI



# ***Dr. GABRIEL TERRA***

***Ensayos contractuales en modelo  
Informe final***

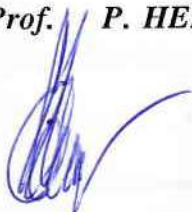
RECIBIDO

19 MAY 1992

Dirección de Obras  
Renovación Terra

***Abril 1992***

***Prof. P. HENRY***



***Eng. H.-P. MOMBELLI***





| INDICE  | pag. |
|---|------|
| 1. OBJETIVO DE LOS ENSAYOS.   | 1    |
| 2. DOCUMENTOS REDACTADOS DE LOS ENSAYOS.                            | 1    |
| 3. PERSONAS QUE HAN PARTICIPADO A LOS ENSAYOS.                      | 1    |
| 4. EL MODELO.   | 2    |
| 5. DESCRIPCION DE LA PLATAFORMA.                                    | 2    |
| 6. INFORME DE CALIBRACION.  | 3    |
| 6.1 Calibración del aparato de medida del caudal.                   | 3    |
| 6.2 Calibración del manometro diferencial de medida del salto       | 5    |
| 6.3 Calibración de par principal                                    | 6    |
| 6.4 Calibración de par de frotamiento                               | 8    |
| 6.5 Calibración del manometro diferencial medido $\Delta P\sigma$ . | 9    |
| 7. CALCULO DE ERROR.  | 11   |
| 7.1 Medida del caudal   | 11   |
| 7.2 Medida de la energia hidraulica                                 | 12   |
| 7.3 Medida de par   | 14   |
| 7.4 Medida de la velocidad de rotación                              | 15   |
| 7.5 Medida del tiempo   | 15   |
| 7.6 Cálculo del rendimiento   | 15   |
| 8. TRANSPOSICION.   | 17   |
| 9. COMENTARIOS SOBRE LOS RESULTADOS DE ENSAYOS.                     | 18   |
| 9.1 Ensayos de rendimiento  | 18   |
| 9.2 Ensayos de cavitación   | 18   |
| 9.3 Ensayos de fluctuación de presión                               | 19   |
| 9.4. Embalamiento   | 19   |
| 10. CONTROL DIMENCIONAL.  | 20   |
| 11. NOTACIONES.   | 20   |

|               |                            |
|---------------|----------------------------|
| <b>328-00</b> | <b>CALIBRACION</b>         |
| <b>328-01</b> | <b>RENDIMIENTO</b>         |
| <b>328-02</b> | <b>CAVITACION</b>          |
| <b>328-03</b> | <b>EMBALAMIENTO</b>        |
| <b>328-04</b> | <b>ESTABILIDAD</b>         |
| <b>328-05</b> | <b>CONTROL DIMENSIONAL</b> |

**UNIVERSAL MODEL TESTING STATION FOR HYDRAULIC  
MACHINES**

**INFORME UTE GABRIEL TERRA.**

Ensayos de recepción del rodete "5-KN-35" comprobado en abril 1992

**1. OBJETIVO DE LOS ENSAYOS.**

Los ensayos hechos en el IMHEF tienen por objetivo:

el control de las potencias y de los rendimientos del rodete 5-KN-35,

el control y el análisis del comportamiento en cavitación de los álabes,

el control y el análisis del comportamiento en cavitación de los álabes,

la medida de la velocidad de embalamiento así como la influencia del sigma sobre esta última,

el análisis de las fluctuaciones de presión y de par,

el control dimensional del modelo a la excepción del rodete,

el control del rodete en casa del constructor en Grenoble.

**2. DOCUMENTOS QUE REGLAMENTAN LOS ENSAYOS.**

Los ensayos han estado conducidos conformes a la demanda No 18.PA579, del programa de ensayos y controles sobre Modelo reducido redactado en la reunión inicial de los ensayos de 30 Marzo 1992 y del Codo de pruebas CEI 193.

**3. PERSONAS QUE HAN PARTICIPADO A LOS ENSAYOS.**

Los ensayos han estado efectuados sobre la plataforma numero 2 del IMHEF y han estado seguidos por:

por UTE

Sra B. TOMALINO  
Sr O. FERRENO

por EDF

Sr A. FRITSCH  
Sr ROBERT

por NEYRPIC

Sr P. VINH

por IMHEF

Prof. P. HENRY  
Sr H. P. MOMBELLI  
Sr G. CRITTIN

**4. EL MODELO.**

El diametro del rodete es de 380 mm, lo que fija la escala a 1/12.76. El modelo comprende las piezas principales siguientes:

una camara espiral en fibras de vidrio, equipada de portijllas que permiten la observación de una parte de las directrices fijas,

un ante-distribuidor formado de 14 directrices fijas en acero inox talladas por comando numerico, y de un pico de camara espiral,

un distribuidor de 24 directrices a armadura metalica envuelta de resina,

una cintura cylindrocónica en plexiglas,

un aspirador de resina epoxy armado de fibras de vidrio reforzado de armaduras metalicas,

un rodete a izquierda a 5 álabes "5-KN-35" en bronze mecanizado por comando numerico, fijados sobre un cubo igualmente en bronze con sistema integrado de regulacion del angulo de los alabes.

**5. DESCRIPCION DE LA PLATAFORMA.**

La descripción de las instalaciones de ensayos y de los aparatos de medida estan dadas en el folleto "UNIVERSAL MODEL TESTING STATION FOR HYDRAULIC MACHINES" adjunto a este informe.



## 6 INFORME DE CALIBRACION.

### 6.1 Calibración del aparato de medida del caudal

El calculo del punto de calibración No 4 de la gama 2 del 31 marzo 1992 esta recalculado a continuación.

Calculo del volumen de agua contenido dentro el estanque antes de llenarlo; ese volumen es dado por la hoja de calibración del estanque en función del nivel leído en el limnimetro No 1

$$Z = Z_B - Z_L - A$$

Donde:

$Z$  = nivel del agua

$Z_B$  = lectura cuando el limnimetro esta a tope

$Z_L$  = lectura cuando el limnimetro toca el nivel

$A$  = longitud de la punta del limnimetro

por el limnimetro No 1.

$$Z_1 = Z_{B1} - Z_{L1} - A_1 \quad (\text{mm})$$

$$Z_1 = 450.6 - 208.4 - 37.96$$

$$Z_1 = 204.24 \text{ mm}$$

Segun la hoja de calibración del estanque volumetrico 00-41 adjuntada, el volumen correspondiente es:

$$V_{Z1} = 3002.46 + \left[ \frac{4003.28 - 3002.46}{215.94 - 169.74} \right] \cdot (204.24 - 169.74)$$

$$V_{Z1} = 3749.8 \text{ dm}^3$$

por el limnimetro superior No 3.

$$Z_S = Z_{BS} - Z_{LS} - A_S \quad (\text{mm})$$

$$Z_S = 450.0 - 160.9 - 37.92$$

$$Z_S = 251.18 \text{ mm}$$

Este valor tiene que estar referido a las temperaturas de las paredes del estanque durante la calibración.

Temperatura mediana de la paredes durante las medidas

TET = 14.0 grados C.

Temperatura mediana de las paredes durante la calibración del depósito volumetrico,

$$TREF = 16.8 \text{ grados C.}$$

Distancia entre los limnimetros 1 y 3,

$$L_{13} = 6214.5 \text{ mm}$$

Valor corregido del nivel  $Z_S$ ,

$$Z_{CO} = Z_S - L_{13} \cdot a \cdot (TREF - TET)$$

donde "a" es el coeficiente de dilatación del hormigón,

$$a = 0.012 \cdot 10^{-3}$$

$$Z_{CO} = Z_S - 6214.5 \cdot 0.012 \cdot 10^{-3} \cdot (16.8 - 14.0)$$

$$Z_{CO} = 250.97 \text{ mm}$$

El volumen  $V_{ZS}$  correspondiente al  $Z_{CO}$  al final del periodo de medida t,

$$V_{ZS} = 139118.24 + \left[ \frac{140119.15 - 139118.24}{283.48 - 237.28} \right] \cdot (250.97 - 237.28)$$

$$V_{ZS} = 139414.9 \text{ dm}^3$$

$$D_{VT} = V_{ZS} - V_{Z1}$$

$$D_{VT} = 135665.0 \text{ dm}^3$$

El volumen introducido esta computado de nuevo en función de TREF,

$$V_{CO} = D_{VT} (1 - b \cdot (TREF - TET))$$

donde "b" es el coeficiente de dilatación cubica del hormigón,

$$b = 0.036 \cdot 10^{-3}$$

$$V_{CO} = 135665.0 (1 - 0.036 \cdot 10^{-3} (16.8 - 14.0))$$

$$V_{CO} = 135651.4 \text{ dm}^3$$

el tiempo de llenar es de,

$$DET = 170.395 \text{ s}$$

y el caudal correspondiente,

$$Q_{etal} = V_{CO} / DET$$

$$Q_{etal} = 0.79610 \text{ m}^3/\text{s}$$

las impulsiones dadas por el aparato de medida del caudal,

$$NIM = 454733$$

Se puede así calcular la frecuencia,

$$Q_{freq} = NIM / DET$$

$$Q_{freq} = 2.6687 \text{ kHz}$$

la pendiente de la recta de calibración es de,

$$Q_{pendiente} = 0.30119 \text{ (m}^3\text{/s)/kHz}$$

la ordenada de la recta de calibración, dependiente directamente del cero del aparato de medida del caudal, es de

$$Q_{ord} = 0.02675 \text{ kHz}$$

Se puede entonces calcular la desviación de frecuencia,

$$Dq_{freq} = \frac{NIM}{DET} - \frac{V_{CO}}{DET} \cdot Q_{pendiente} - Q_{ord}$$

$$Dq_{freq} = -1.23 \text{ Hz}$$

y después la desviación relativa en por Mil,

$$Dq_{rel} = \frac{Dq_{freq}}{Q_{freq} - Q_{ord}}$$

$$Dq_{rel} = -0.46 \text{ ‰}$$

## 6.2 Calibración del manómetro diferencial de medida del salto

La calibración del manómetro diferencial de medida del salto (captador HBM PD1 No 2944) se hace por comparación con un manómetro a mercurio montado en paralelo. La presión leída al manómetro a mercurio se convierte en frecuencia utilizando la pendiente y la ordenada de la recta de calibración. Esta frecuencia calculada es entonces sustraída de la señal en frecuencia dada por el captador, la diferencia es llamada diferencia de frecuencia real. Para obtener la desviación relativa, es suficiente dividir la desviación de frecuencia real por la frecuencia calculada disminuida de la ordenada de la recta de calibración.

Ejemplo de cálculo del primero punto de la hoja de calibración del 30 marzo 1992.

La presión leída al manómetro a mercurio,

$$H_{etal} = 0.39790 \text{ m Hg}$$

La frecuencia calculada,

$$H_{frdr} = \frac{H_{etal}}{H_{pendiente}} + H_{ord}$$

donde:

$H_{pendiente}$  = pendiente de la recta de calibración

$H_{ord}$  = ordenada al origen de la recta de calibración

$$H_{frdr} = \frac{0.39790}{0.08170} + 0.1193$$

$$H_{frdr} = 4.9896 \text{ kHz}$$

la diferencia de frecuencia real,

$$Dh_{freq} = H_{freq} - H_{frdr}$$

donde:

$H_{freq}$  = frecuencia dada por el captador

$$H_{freq} = 4.9860 \text{ kHz}$$

$$Dh_{freq} = -3.56 \text{ Hz}$$

la diferencia relativa,

$$Dhf_{rel} = \frac{Dh_{freq}}{H_{frdr} - H_{ord}}$$

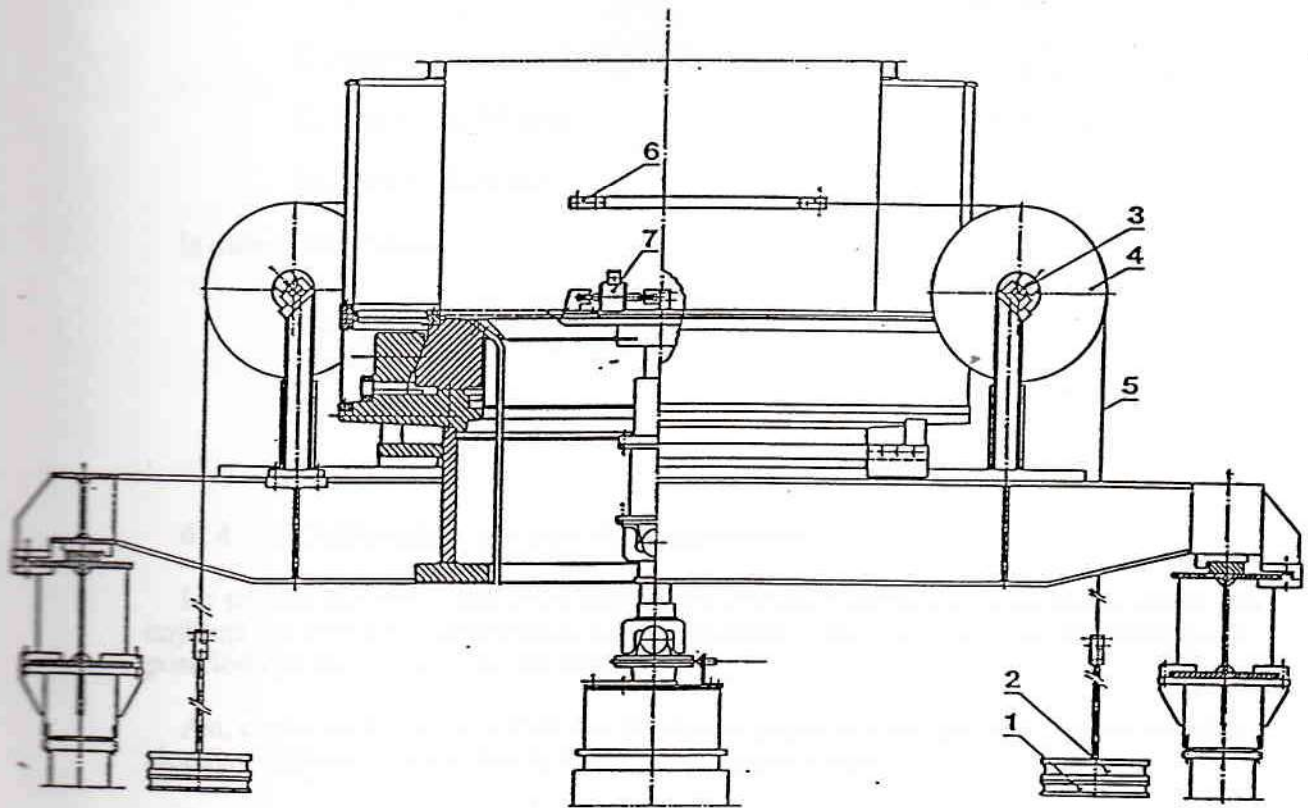
$$Dhf_{rel} = -0.73 \text{ ‰}$$

### 6.3 Calibración de par principal.

La generatriz estando montada sobre un cojinete de empuje hidroestático, la medida de par se reduce a la medida de la fuerza de reacción sobre un punto fijo del estator de la máquina eléctrica. La operación de calibración de esta medida consiste en aplicar sobre el estator de la generatriz una fuerza a la ayuda de un sistema de cintas metálicas de poleas de bandeja y de masas taradas (vease figura).

Se pasa al valor de par multiplicando la fuerza por el diámetro del estator de la generatriz medido al punto de aplicación de las cintas.





Dispositivo de calibración del dinamometro

1. Bandeja, 2. Pesos, 3. Cuchillos, 4. Poleas, 5. Cintas 6. Fijación, del estator, 7. Captador de fuerza.

Ejemplo de cálculo del primero punto de la hoja de calibración del 30 marzo 1992.

La masa puesta sobre las bandejas,

$$C_{etal} = 40.1847 \text{ kg}$$

La frecuencia calculada

$$C_{frdr} = \frac{C_{etal}}{C_{pendiente}} + C_{ord}$$

donde

$C_{pendiente}$  = pendiente de la recta de calibración

$C_{ord}$  = ordenada al origen de la recta de calibración

$$C_{frdr} = \frac{40.1847}{24.80748} + 0.19442$$

$$C_{frdr} = 1.8143 \text{ kHz}$$

La diferencia de frecuencia real,

$$Dc_{freq} = C_{freq} - C_{frdr}$$

donde

$C_{freq}$  = frecuencia dada por el captador

$C_{freq} = 1.8135 \text{ kHz}$

$Dc_{freq} = -0.78 \text{ Hz}$

la diferencia relativa,

$$Dcf_{rel} = \frac{Dc_{freq}}{C_{frdr} - C_{ord}}$$

$Dcf_{rel} = -0.48 \text{ ‰}$

#### 6.4 Calibración de par de frotamiento.

Lo mismo que por la par principal, el soporte de la turbina esta montado sobre un cojinete de empuje hidroestatico (cubo oscilante). Este ultimo está mantenido en posición fija por un captador de fuerza.

Asi, como por la par principal, la calibración consiste a comparar y calibrar la señal electrica dada por el captador de fuerza cargado con masas taradas.

Se pasa al valor de par multiplicando la fuerza por el rayo medido al punto de aplicación del captador.

La par de frotamiento esta seguido adjunta a la par principal.

Ejemplo del calculo del primero punto de la hoja de calibración de 30 marzo 1992.

La carga aplicada al captador de fuerza,

$Tif_{etal} = 2.0035 \text{ kg}$

La frecuencia calculada,

$$Tif_{frdr} = \frac{Tif_{etal}}{Tif_{pendiente}} + Tif_{ord}$$

donde

$Tif_{pendiente}$  = pendiente de la recta de calibración

$Tif_{ord}$  = ordenada al origen de la recta de calibración

$$Tif_{frdr} = \frac{2.0035}{0.91743} + 0.14606$$

$Tif_{frdr} = 2.3299 \text{ kHz}$

diferencia de frecuencia real,

$$Dtif\_freq = Tif\_freq - Tif\_frdr$$

donde

$Tif\_freq$  = frecuencia dada por el captador

$$Tif\_freq = 2.3295 \text{ kHz}$$

$$Dtif\_freq = -0.38 \text{ Hz}$$

diferencia relativa,

$$Dtii\_rel = \frac{Dtif\_freq}{Tif\_frdr - Tif\_ord}$$

$$Dtiff\_rel = -0.17 \text{ ‰}$$

## 6.5 Calibración del manómetro diferencial de medida de $\Delta P\sigma$ .

La calibración del manómetro diferencial de medida de  $\Delta P\sigma$  se hace por comparación con un manómetro a mercurio montado en paralelo. La presión leída al manómetro a mercurio se convierte en frecuencia utilizando la pendiente y la ordenada de la recta de calibración. Esta frecuencia calculada es entonces sustraída de la señal en frecuencia dada por el captador; la diferencia es llamada diferencia de frecuencia real. Para obtener la diferencia relativa es suficiente dividir la diferencia de frecuencia real por la frecuencia calculada disminuida de la ordenada de la recta de calibración.

Ejemplo de calculo del primero punto de la hoja de calibración del 03 abril 1992.

La presión leída al manómetro a mercurio,

$$S\_etal = 0.31940 \text{ m Hg}$$

La frecuencia calculada,

$$S\_frdr = \frac{S\_etal}{S\_pendiente} + S\_ord$$

donde

$S\_pendiente$  = pendiente de la recta de calibración

$S\_ord$  = ordenada al origen de la recta de calibración.

$$S\_frdr = \frac{0.31940}{0.08299} + 0.1284$$

$$S\_frdr = 3.9771 \text{ kHz}$$

diferencia de frecuencia real,

$$Ds\_freq = S\_freq - S\_frdr$$

donde

$S\_freq$  = frecuencia dada por el captador

$$S\_freq = 3.9734 \text{ kHz}$$

$$Ds\_freq = -3.66 \text{ Hz}$$

diferencia relativa,

$$Dsf\_rel = \frac{Ds\_freq}{S\_frdr - S\_ord}$$

$$Dsf\_rel = -0.95 \text{ ‰}$$



## 7. CALCULO DE ERROR.

### 7.1 Medida del caudal

La medida del caudal se efectúa por un aparato electromagnetico KENT, No AJ 3467, asociado a una unidad de detección y de amplificación BBC KENT. Este aparato posee 2 gamas de medida por el funzonamiento en turbina y lo mismo por el funzonamiento en bomba.

la gama No 1 mide de 0 à 200 l/s

la game No 2 mide de 200 à 1400 l/s

El sistema electrónico abastece una frecuencia de 5000 Hz por valores máximas de cada gama.

El caudal esta dado por la relación siguiente

$$\dot{V} = Q_{\text{pendiente}} \left( \frac{\text{NIV}}{t} - Q_{\text{ord}} \right)$$

donde:

$Q_{\text{pendiente}}$  = pendiente de la recta de calibración

NIV = nombre de impulsiones abastecidas durante el tiempo de medida

t = tiempo de medida

$Q_{\text{ord}}$  = ordenada al origen de la recta de calibración

Los coeficientes de calibración son obtenidos comparando los valores dados por el estanque volumetrico de 150 m<sup>3</sup> a los dados por el aparato de medida del caudal.

El estanque volumetrico a estado calibrado por la OFICINA FEDERAL DE PESOS Y MEDIDAS, en marzo 1969, abril 1971, marzo 1973, junio 1977 y julio 1987. La concordancia de los resultados a sido excelente.

La calibración a estado efectuada por medio de un pequeño depósito de una capacidad de 1 m<sup>3</sup>, administrado por la OFICINA FEDERAL DE PESOS Y MEDIDAS. La precisión de medida es  $\pm 0.05\%$ . El nivel del agua a estado medido con un limnimetro, entre una marca en el muro y el nivel de agua dentro el depósito. La presión es del orden de  $\pm 0.02\%$ . Los otros errores debido a la temperatura, la evaporación, etc, podrian estar estimados à  $\pm 0.01\%$ . El resultado de la ultima calibración efectuada en julio 1987 esta dado con el certificado 00-41.

El error fortuito introducido por la calibración es dado por la dispersión de los puntos en la hoja de calibración.

Este error fortuito es del orden de  $\pm 0.05\%$ .

El error total maximo esta dado por la suma de los errores sistemático y fortuito.

Entonces el error total maximo sobre la medida del caudal es de  $\pm 0.13 \%$ .

$$e_{\dot{V}} = \pm 0.13$$

## 7.2 Medida de la energia hidraulica.

La energia hidraulica es la suma de las energias potenciales especificas y de la energia cinetica especifica,

$$gH = gH_P + gH_C$$

La energia potencial  $gH_P$  se puede calcular multiplicando por  $g$  la presión  $H_P$  medida directamente por un manometro diferencial, cuando la energia cinetica  $gH_C$  se determina a partir de la medida de caudal y conociendo el area de las secciones rio arriba y rio abajo.

$S_I$  = sección de medida rio arriba

$S_{\bar{I}}$  = sección de medida rio abajo

Se ha adoptado, por la medida de  $H_P$ , un captador de presión diferencial de tipo inductivo con un campo de medida de 0 à 10 mCE.

La relación que da la energia potencial  $gH_P$  medida, en función de la señal delivrada por el captador, es la siguiente:

$$gH_P = \frac{g\Delta\mu}{\mu_e} H_{\text{pendiente}} \left( \frac{NIH}{t - H_{\text{ord}}} \right)$$

donde:

$\Delta\mu$  = diferencia de masas volumicas de mercurio y de agua

$\mu_e$  = masa volumica del agua a la temperatura de ensayos

$H_{\text{pendiente}}$  = pendiente de la recta de calibración

$NIH$  = nombre de impulsiones abastecidas durante el tiempo de medida

$t$  = tempo de medida

$H_{\text{ord}}$  = ordenada al origen de la recta de calibración

El valor  $\Delta\mu$  es introducido porque el captador de presión es contrastado por comparación con un manometro a mercurio.

El valor de  $\mu_e$ , masa volumica del agua a la temperatura de ensayos es dada por la relación siguiente, sacada de las normas CEI.

$$\mu_e = 1000.1800014 + 0.0084284 T_e - 0.0052857 T_e^2$$

donde

$T_e$  = temperatura del agua de ensayos

Los valores de  $H_{pendiente}$  y de  $H_{ord}$  son determinados por una calibración que consiste en una comparación directa entre las presiones leídas sobre el manometro a mercurio y las dadas por el sistema electrónico.

El error sistemático sobre la calibración, teniendo en cuenta las imprecisiones de lectura, es del orden  $\pm 0.04 \%$ .

La ordenada  $H_{ord}$  al origen es introducida para disminuir las diferencias debidas al no alineamiento de la característica del captador.

La hoja "Calibración del salto" de 30 marzo 1992 representa las diferencias obtenidas cuando la calibración inicial en funcion de la frecuencia.

$$Dh_{freq} = \frac{NIH}{t} - \frac{H_{etal}}{H_{pendiente}} - H_{ord}$$

$H_{pendiente}$  = de la recta de calibración

NIH = nombre de impulsiones abastecidas durante el tiempo de medida

$t$  = tiempo de medida

$H_{ord}$  = ordenada al origen de la recta de calibración

$$Dhf_{rel} = \frac{DH_{freq}}{H_{frdr} - H_{ord}}$$

El error fortuito introducido por la calibración es dado por la dispersión de los puntos en la hoja de calibración.

Este error fortuito es del orden de  $\pm 0.04 \%$  por medio.

El error total maximo es dado por la suma de los errores sistematico y fortuito.

$$e_H = \pm 0.08 \%$$

### 7.3 Medida de par.

El estator de la maquina electrica esta montado sobre un cojinete de empuje hidroestático; la medida de par corresponde a una medida de fuerza. Esta fuerza es medida por dos captadores HOTTINGER-BALDWIN Z3 H2, de una capacidad maximal de 1000 N.

El sistema electrónico de amplificación es un aparato HBM.

La par es dada por la relación siguiente,

$$T_i = g C_{\text{pendiente}} \left( \frac{\text{NIT}}{i} - C_{\text{ord}} \right) \cdot L$$

donde:

$g$  = aceleración terrestre local

$C_{\text{pendiente}}$  = pendiente de la recta de calibración

$\text{NIT}$  = nombre de impulsiones abastecidas durante el tiempo de medida

$t$  = tiempo de medida

$C_{\text{ord}}$  = ordenada al origen de la derecha de calibración

$L$  = longitud de los brazos de palanca

Las diferencias son dadas comparando la masa total  $C_{\text{tabla}}$  suspendida a las cintas con el nombre de impulsiones abastecidas por el sistema electrónico.

La hoja "Calibración de par" de 30 marzo 1992 representa las diferencias obtenidas cuando la calibración inicial en función de la frecuencia.

$$Dc_{\text{freq}} = \frac{\text{NIT}}{t} - \frac{C_{\text{etal}}}{C_{\text{pendiente}}} C_{\text{ord}}$$

$C_{\text{pendiente}}$  = pendiente de la recta de calibración

$\text{NIT}$  = nombre de impulsiones abastecidas durante el tiempo de medida

$t$  = tempo de medida

$C_{\text{ord}}$  = ordenada al origen de la recta de calibración

y

$$Dcf_{\text{rel}} = \frac{Dc_{\text{freq}}}{C_{\text{frdr}} - C_{\text{ord}}}$$

los puntos en la hoja de calibración.

Este error fortuito es del orden de  $\pm 0.02$  % de medio.



Los errores sistemáticos son debidos a la medida del brazo de la palanca y a la precisión de la calibración de pesos.

El diametro del estator de la maquina electrica esta medido con una precisión de  $\pm 0,03\%$  teniendo en cuenta una pequeña diferencia de temperatura.

Los pesos han estado calibrados por la "OFICINA FEDERAL DE PESOS Y MEDIDAS" con una precisión de  $\pm 0.3 \cdot 10^{-3}$  kg por 25 kg

El error relativo maximal es de  $\pm 0.01 \%$ , teniendo en cuenta los errores posibles añadidos con la manipulación de los pesos.

La par de frotamiento esta medida de una manera identica y el nivel de precisión es el mismo, pero el valor de este representa  $2\%$  de la par principal. El error cometido sobre su medida puede estar descuidado.

El error relativo maximal por la medida de par es la suma de los errores citados mas arriba.

$$e_T = 0.06 \%$$

#### 7.4 Medida de la velocidad de rotación.

La velocidad de rotación esta medida a la ayuda de un rodete dentado de 60 dientes y de un captador magnetico.

La fidelidad es de  $\pm 1$  pulsación. Por una velocidad de rotación de 600 t/min y por un tiempo de computación de 30 s, el nombre de pulsaciones es de 18000. El error es descuidable. Es posible controlar este error.

#### 7.5 Medida del tiempo.

La medida del tiempo aparece en todos los valores calculados. El tiempo de base definido por OSCILLOQUARTZ a estado calibrado por l'"OBSERVATORIO CANTONAL DE NEUCHATEL". La precisión es mejor que  $10^{-6}$  y el error es descuidable.

#### 7.6 Cálculo del rendimiento.

El cálculo del rendimiento esta efectuado por la formula:

$$\eta_i = \frac{T_i \cdot N_m}{\mu \cdot \dot{V} \cdot gH}$$

El error sistemático en el rendimiento esta dado por

$$e_{\eta} = \pm \sqrt{e_V^2 + e_H^2 + e_T^2}$$

El error en la masa volumica y en la energia cinetica es descuidado.

Por un punto de medida cerca de la cumbre la colina de rendimiento, el error es de

$$e_{\eta} = \sqrt{0.13^2 + 0.08^2 + 0.06^2}$$

$$e_{\eta} = \pm 0.16\%$$

El sistema de adquisición de datos abastece el valor medio de todas las medidas hechas durante un periodo determinado. Este periodo puede estar reglado para obtener una fiabilidad dentro la medida de rendimiento mejor que  $\pm 0,1\%$ .

Este error fortuito puede estar estimado midiendo el mismo punto varias veces y comparando los resultados. La experiencia muestra que, dentro un tiempo de medida de 30 s, el error fortuito es menor de 0,1%.

$$e_{\eta R} = \pm 0.10\%$$

Siguiendo los valores mas arriba, el error total puede estar calculado utilizando la formula:

$$e_{\eta T} = \pm \sqrt{e_{\eta}^2 + e_{\eta R}^2}$$

$$e_{\eta T} = \pm \sqrt{0.16^2 + 0.10^2}$$

$$e_{\eta T} = \pm 0.19\%$$

## 8. TRANSPOSICION.

El cálculo de la transposición modelo-prototipo y el cálculo de rendimiento medio ponderado estan presentados en las hojas AR1, AR2 y AR3 manuscritas y firmadas durante los ensayos.

La transposición se hace utilizando la formula de HUTTON

$$\eta_p = 1 - (1 - \eta_m) \left[ 0.3 + 0.7 \left\{ \frac{D_m}{D_p} \cdot \frac{v_p}{v_m} \cdot \sqrt{\frac{H_m}{H_p}} \right\}^{1/5} \right]$$

Los datos del modelo son los siguientes:

|                       |   |
|-----------------------|---|
| temperatura del agua  | 16.5°C                                      |
| viscosidad cinematica | $1.0933 \cdot 10^{-6} \text{ m}^2/\text{s}$ |
| salto de ensayos      | 6 mCE                                       |
| diámetro del rodete   | 0.380 m                                     |

Los datos del prototipo son los siguientes:

|                       |  |
|-----------------------|--|
| temperatura del agua  | 20°C                                       |
| viscosidad cinemática | $1.004 \cdot 10^{-6} \text{ m}^2/\text{s}$ |
| salto de ensayos      | 17 - 21 - 25 mCE                           |
| diámetro del rodete   | 4.848 m                                    |

La transposición de la potencia es dada por la relación siguiente:

$$P = \eta_p \cdot \rho_p \cdot g_p \cdot Q_p \cdot H_p$$

con el complemento de datos siguiente:

|                   |                        |
|-------------------|------------------------|
| densidad del agua | $998.2 \text{ kg/m}^3$ |
| g prototipo       | $9.7947 \text{ m/s}^2$ |

Las relaciones mas arriba permiten de calcular el rendimiento medio ponderado medido y de compilar la tabulación siguiente:

| salto<br>( m ) | potencia |       | pond. | rendimiento |        |
|----------------|----------|-------|-------|-------------|--------|
|                | %Pmax    | (MW)  |       | garantizado | medido |
| 25.0           | 95       | 36.86 | 10    | 92.70       | 94.10  |
| 25.0           | 85       | 32.98 | 10    | 93.25       | 94.20  |
| 25.0           | 75       | 29.10 | 7     | 93.50       | 94.10  |
| 25.0           | 65       | 25.22 | 5     | 93.45       | 93.90  |
| 25.0           | 55       | 21.34 | 4     | 93.10       | 93.70  |
| 25.0           | 45       | 17.46 | 2     | 92.35       | 93.10  |
| 21.0           | 85       | 32.98 | 5     | 91.15       | 93.60  |
| 21.0           | 75       | 29.10 | 10    | 92.65       | 93.90  |
| 21.0           | 65       | 25.22 | 9     | 93.10       | 93.60  |
| 21.0           | 55       | 21.34 | 8     | 93.20       | 93.40  |

| salto<br>( m ) | potencia |       | pond. | rendimiento |        |
|----------------|----------|-------|-------|-------------|--------|
|                | %Pmax    | (MW)  |       | garantizado | medido |
| 21.0           | 45       | 17.46 | 6     | 92.70       | 93.00  |
| 17.0           | 65       | 25.22 | 5     | 90.25       | 92.80  |
| 17.0           | 55       | 21.34 | 10    | 92.10       | 93.00  |
| 17.0           | 45       | 17.46 | 9     | 92.45       | 92.50  |

El rendimiento medio ponderado medido = 93.53 %.

El rendimiento medio ponderado garantizado = 92.65 %.

## 9. COMENTARIOS SOBRE LOS RESULTADOS DE ENSAYOS.

### 9.1 Ensayos de rendimiento.

Los 1, 2 y 3 abril, los rendimientos han estado medidos para cubrir una <sup>zona</sup>playa en  $n_{11}$  variante de 100 a 165 t/min y por 7 aberturas del rodete. Los resultados obtenidos encuadrando bien el campo de utilización previsto. Además una exploración a  $n_{11}$  constante a estado efectuado por los saltos prototipo de 17,21 y 25 m. El rendimiento medio ponderado es de 93.53%. Este rendimiento a estado obtenido en utilizando la formula de trasposición de Hutton.

El rendimiento medio ponderado garantizado es de 92.65%.

El 03 abril, un control de la calibración del caudal a permitido de confirmar los parametros de las calibraciones del 30 marzo.

### 9.2 Ensayos de cavitación.

Los ensayos siguientes han estado efectuados:

Medida de la curva  $\eta - \sigma$  con fotos y croquis de observación por 4 puntos de funcionamiento que son:

|            |       |       |        |              |
|------------|-------|-------|--------|--------------|
| $n_{11}$ : | 132.2 | 132.2 | 118.85 | 151.5 tr/min |
| $Q_{11}$   | 1608  | 1472  | 1356.6 | 1755 l/s     |

Observación al sigma de instalación por 2 puntos de funcionamiento:

|          |       |            |
|----------|-------|------------|
| $n_{11}$ | 132.2 | 147 tr/min |
| $Q_{11}$ | 259.4 | 313 l/s    |

Los curvas  $\eta - \sigma$  muestran que el rendimiento no es afectado por la cavitación al sigma de instalación.

La cavitación marginal al sigma de instalación no es muy importante dentro de la zona controlada.

La cavitación del cubo (del rodete) coje nacimiento dentro el juego entre pala y cubo.

La cavitación de entrada intradós y extradós de regimes extremos no cuvre que una parte del borde de entrada.

### 9.3 Ensayos de fluctuación de presión.

Las fluctuaciones de presión han estado medidas dentro la sección de medida a la entrada del caracol y dentro el cono de aspirador.

Grabaciones y análisis han estado efectuados dentro la zona de funcionamiento en conjugación por 3 valores de  $n_{11}$  y 6 aberturas del rodete.

$n_{11} = 121.2 \quad 132.2 \quad 147.0 \text{ tr/min}$

$\alpha_p = 6^\circ \quad 12^\circ \quad 18^\circ \quad 24.1^\circ \quad 30.1^\circ \quad 34^\circ$

Las fluctuaciones de presión no son importantes dentro del campo normal de utilización (terreno garantizado); alcanzan al maximo 0.3% del salto neto.

Fuera de esta zona, las fluctuaciones se quedan siempre inferiores a 1% del salto neto.

### 9.4. Embalamiento.

Una colina de embalamiento fuera cavitación a estado establecida con las inclinaciones de álabes siguientes:

$\alpha_p = 6^\circ \quad 16^\circ \quad 18^\circ \quad 20^\circ \quad 24^\circ \quad 29^\circ \quad 30^\circ \quad 36^\circ$

El valor maximo de  $n_{11}$  medido es de 271 tr/min.

Un control de la influencia de la cavitación a estado hecho por la abertura que da la mas grande velocidad de embalamiento ( $\alpha_p = 19^\circ$  et  $\gamma_d = 39.3 \text{ mm}$ ).

Bajo la influencia de la cavitación el valor  $n_{11}$  medido es de 298.2 tr/min.

El resultado es una velocidad de embalamiento maximum maximorum por el prototipo, con un salto de 28 m, de 325.5 tr/min.

Los ensayos muestran que la velocidad maximal de embalamiento garantizada de 330 tr/min no será alcanzada.

## 10. CONTROL DIMENCIONAL.

El control dimensional comprende tres etapas importantes:

1. Un control de homologia del modelo en sus dimensiones principales. Estas medidas son descritas sobre forma de esquemas y tabulaciones en los adjuntos del informe.  
  
Dentro el cuadro del mismo control, una plantilla <sup>col</sup>del techo del aspirador a estado realizada en madera segun el dibujo teorico y las diferencias han sido medidas; se ha constatado que son siempre inferiores que la tolerancia de 2%.
2. El cóno en plexiglas y una directriz han sido controlados sobre nuestra mesa a digitalizar. La medida a sido hecha por dos secciones verticales del cóno y tres secciones horizontales de la directriz 1.
3. El rodete a sido controlado en la casa NEYRPIC en GRENOBLE el 10 abril 1992. La medida de las diferencias es adjunta al informe.

## 11. NOTACIONES.

|                          |                       |          |
|--------------------------|-----------------------|----------|
| $\dot{V}$                | Caudal                | $m^3/s$  |
| $gH$                     | Salto                 | $J/Kg$   |
| $T_i$                    | Par                   | $Nm$     |
| $Nm$                     | Velocidad de rotacion | $rpm$    |
| $Te$                     | Temperatura del agua  | $deg. C$ |
| $N = \frac{2\pi.Nm}{60}$ |                       | $rad/s$  |

Calculo del rendimiento

$$\eta_i = \frac{T_i \cdot N}{\mu \cdot \dot{V} \cdot gH}$$

Calculo de las coordenadas reducidas

$$n_{11} = \frac{\dot{N}m \cdot 2R}{\sqrt{H}}$$

$$Q_{11} = \frac{\dot{V}}{4R^2 \cdot \sqrt{H}}$$

Calculo de las coordenadas adimensionales

$$\Phi_{1e}^- = \frac{\dot{V}}{\pi \cdot R^3 \cdot N}$$

$$\Psi_{1e}^- = \frac{2 \cdot g \cdot H}{(R \cdot N)^2}$$

Calculo del coeficiente de Thoma

$$\sigma = \frac{H_a - H_v - H_s}{H}$$

$$H_s = \frac{\Delta P \sigma}{\mu_e \cdot g}$$

mWC

|    |                                   |                   |
|----|-----------------------------------|-------------------|
| Np | Velocidad de rotacion de la bomba | rpm               |
| R  | Rayo de referencia del rodete     | m                 |
| g  | Aceleracion por gravedad (9.8063) | m/s <sup>2</sup>  |
| μe | Densidad del agua                 | Kg/m <sup>3</sup> |
| v  | Viscosidad del agua               | m <sup>2</sup> /s |

***328-00***

***CALIBRACION***





DÉPARTEMENT DE LA JUSTICE, DE LA POLICE ET DES AFFAIRES MILITAIRES

## BUREAU CANTONAL DES POIDS ET MESURES

CENTRE DE LA BLÉCHERETTE

1014 LAUSANNE

TÉL. (021) 21 01 11

Lausanne, le 16 septembre 1987

100

1000 dans la correspondance, s.v.p.

Ecole polytechnique fédérale  
Institut de machines hydrauliques  
Avenue de Cour 33  
1007 LAUSANNE

Résultats de l'étalonnage du bassin volumétrique du stand  
d'essais universel de l'institut des machines hydrauliques  
de l'école polytechnique fédérale de Lausanne en date du  
23 juin au 3 juillet 1987.

Température moyenne des parois:  $T_m^0 = 16,8^{\circ}\text{C}$ .

|              | Niveau Z<br>(mm) | Volume $V$<br>( $10^{-3}\text{m}^3$ ) |
|--------------|------------------|---------------------------------------|
| Limnimètre 1 | 30.94            | 0.00                                  |
|              | 77.34            | 1000.82                               |
|              | 123.54           | 2001.64                               |
|              | 169.74           | 3002.46                               |
|              | 215.94           | 4003.28                               |
|              | 262.04           | 5004.10                               |
|              | 308.14           | 6004.92                               |
|              | 354.24           | 7005.74                               |
|              | 400.34           | 8006.56                               |
|              | 446.44           | 9007.38                               |
| Limnimètre 2 | 3.41             | 70057.40                              |
|              | 49.61            | 71058.22                              |
|              | 95.81            | 72059.04                              |
|              | 142.01           | 73059.86                              |
|              | 188.31           | 74060.68                              |
|              | 234.51           | 75061.50                              |
|              | 281.11           | 76062.32                              |
|              | 327.91           | 77063.14                              |
|              | 374.31           | 78063.96                              |
|              | 420.31           | 79064.78                              |



00 - 41b

DÉPARTEMENT DE LA JUSTICE, DE LA POLICE ET DES AFFAIRES MILITAIRES

## BUREAU CANTONAL DES POIDS ET MESURES

CENTRE DE LA BLÉCHERETTE

1014 LAUSANNE

TÉL. (021) 21 01 11

Lausanne, le 16 septembre 1987

à appeler dans la correspondance, s.v.p.

|           | Niveau Z<br>(mm) | Volume $10^{-3} V$<br>(m <sup>3</sup> ) |
|-----------|------------------|---|
| Limétre 3 | 6.68             | 134113.69                               |
|           | 52.78            | 135114.60                               |
|           | 98.88            | 136115.51                               |
|           | 145.08           | 137116.42                               |
|           | 191.18           | 138076.87                               |
|           | 237.28           | 139118.24                               |
|           | 283.48           | 140119.15                               |
|           | 329.58           | 141120.06                               |
|           | 375.78           | 142120.97                               |
|           | 422.08           | 143121.88                               |

Bureau cantonal des  
POIDS ET MESURES  
Centre de la Blécherette  
1014 LAUSANNE

DÉPARTEMENT DE LA JUSTICE, DE LA POLICE ET DES AFFAIRES MILITAIRES

## BUREAU CANTONAL DES POIDS ET MESURES

CENTRE DE LA BLÉCHERETTE

1014 LAUSANNE

TÉL. (021) 21 01 11

Lausanne, le 16 septembre 1987

V/rét.

N/rét. WO

Ecole polytechnique fédérale  
Institut de machines hydrauliques  
Avenue de Cour 33  
1007 LAUSANNE

Détermination de la distance entre les butées

Les distances entre les trois butées ont été mesurées par nos soins, le 25.06.87, à l'aide d'un ruban métallique gradué et d'un niveau optique. Afin de garantir une température constante, le bassin d'étalonnage était plein d'eau et le bassin principal rempli à la cote 2,30.

Les températures relevées dans l'eau et au-dessus de la surface du grand bassin, ainsi que dans l'eau du bassin volumétrique étaient très voisines de  $16,7^{\circ}\text{C}$  si bien que l'on peut admettre une température des murs du bassin d'étalonnage de  $16,7^{\circ}\text{C}$ .

Distances mesurées à  $16,7^{\circ}\text{C}$ : $L_{12} = 3258,7 \text{ mm}$  $L_{13} = 6214,5 \text{ mm}$ Mesure de la longueur des pointes

La longueur des pointes des trois limnimètres a été mesurée, par nos soins, le 25.06.87 à l'aide d'un calibre de profondeur.

Pointe du limnimètre A1 : 37,96 mm

Pointe du limnimètre A2 : 38,19 mm

Pointe du limnimètre A3 : 37,92 mm

Bureau cantonal des  
POIDS ET MESURES  
Centre de la Blécherette  
1014 LAUSANNE

*h. L...*  
309 C-3



DÉPARTEMENT DE LA JUSTICE, DE LA POLICE ET DES AFFAIRES MILITAIRES  
Service de la police administrative

# BUREAU CANTONAL DES POIDS ET MESURES

Tél. (021) 210111  
Tél. (021) 642 81 11

CENTRE DE LA BLÉCHERETTE

1014 LAUSANNE

1/1

correspondance, s.v.p.

Ecole Polytechnique Fédérale  
Laboratoire de machines hydrauliques  
Av. de Cour 33  
1007 LAUSANNE

Lausanne, le 19 mai 1989

## A T T E S T A T I O N

~~Je~~ certifie avoir étalonné deux supports avec divers éléments  
à  $10 \text{ kg} \pm 0,5 \text{ g}$

~~Les~~ éléments compris dans la masse étalonnée sont:

- 1 plateau
- 1 barre cylindrique de support
- 1 écrou (fixant le plateau à la barre de support)
- 1 rotule
- 1 goupille (fixant la rotule à la barre de support)
- 1 pince-ruban, formé de deux parties serrées sur le ruban avec deux vis
- 1 axe avec un circlips (permettant la liaison d'ensemble: plateau-barre de support-rotule, avec le pince-ruban)

\* \* \*

2 disques  $\varnothing 150$  de 5 kg étalonnés à  $\pm$  20 mg

3 disques  $\varnothing 300$  de 25 kg " à  $\pm$  300 mg

\* \* \*

Le vérificateur:

M. Magnenat

*d. Magnenat*

Bureau cantonal des  
POIDS ET MESURES  
Centre de la Blécherette  
1014 LAUSANNE



## BUREAU CANTONAL DES POIDS ET MESURES

Centre de la Blécherette 1001 Lausanne Tél. (021) 21 01 11

Lausanne, le 15 mai 1989

Ecole Polytechnique Fédérale de Lausanne  
I.M.H.E.F.  
33, avenue de Cour

1007 LAUSANNEConcerne: Etalonnage d'une balance manométrique

ASTRO: type 22,6 Nr. 1508/70 7 - 110 mCE.

1) Mesure du diamètre du piston et calcul de sa surface.

diamètre du piston: 22,538 mm  $\pm$  1  $\mu$ surface: 398,95 mm<sup>2</sup> = 3,9895 cm<sup>2</sup>

2) Pesage des poids et détermination de leurs erreurs.

| Poids Nr    | Poids en g. |           | Erreurs     |             |
|-------------|-------------|-----------|-------------|-------------|
|             | Théoriques  | Effectifs | Absolues g. | Relatives % |
| piston 7mCE | 2792.67     | 2792.64   | - 0.03      | - 0.0       |
| F1 1mCE     | 398.95      | 397.88    | - 1.07      | - 0.253     |
| E1 2mCE     | 797.91      | 789.55    | - 8.37      | - 1.046     |
| E2 "        | "           | 802.26    | +4.35       | +0.546      |
| D1 5mCE     | 1994.76     | 1995.18   | +0.42       | +0.022      |
| C1 10mCE    | 3989.53     | 3996.75   | +7.22       | +0.182      |
| C2 "        | "           | 4001.65   | +12.12      | +0.305      |
| B1 20mCE    | 7979.06     | 7960.30   | - 18.76     | - 0.234     |
| B2 "        | "           | 7992.06   | +13.00      | +0.164      |
| B3 "        | "           | 7991.10   | +12.04      | +0.152      |
| B4 "        | "           | 7989.00   | +9.94       | +0.125      |

Précision du pesage:  $\pm$  0.05 g



OBSERVATOIRE CANTONAL

2418 61 - 62

2000 Neuchâtel, le 20 juillet 1977

Rue de l'Observatoire 58

EPFL

Institut de Machines Hydrauliques  
Avenue de Cour, 33

1000 L a u s a n n e

Contrôle de la fréquence du quartz 10 kHz de l'unité  
1402.1 no. 131, de l'appareil B-1352

|                                      |                     |
|--------------------------------------|---------------------|
| 5 min. après enclenchement:          | + $4 \cdot 10^{-6}$ |
| 10 min. après enclenchement:         | + $3 \cdot 10^{-6}$ |
| 20 min. après enclenchement:         | + $2 \cdot 10^{-6}$ |
| 1 heure après enclenchement:         | + $5 \cdot 10^{-7}$ |
| 1 h 20 min. après enclenchement:     | + $3 \cdot 10^{-7}$ |
| 1 h 30 min. après enclenchement:     | + $2 \cdot 10^{-7}$ |
| 2 h 10 min. après enclenchement:     | - $5 \cdot 10^{-7}$ |
| 3 h après enclenchement:             | - $9 \cdot 10^{-7}$ |
| 3 h 30 à 5 h 30 après enclenchement: | - $1 \cdot 10^{-6}$ |
| 23 h 30 après enclenchement:         | - $2 \cdot 10^{-7}$ |

Températures pendant les mesures: 21-24°C

L'affichage sur 1000 secondes correspond effectivement à  
la fréquence du quartz:

temps indiqué: 999<sup>S</sup>.999

temps réel: 1000<sup>S</sup>.000

fréquence du quartz pendant cette mesure:  $-1 \cdot 10^{-6}$

Le signe + indique une fréquence trop grande

Le signe - indique une fréquence trop petite.

Référence: Horloge Césium HP 5061A.

OBSERVATOIRE DE NEUCHÂTEL

(G. Jornod)



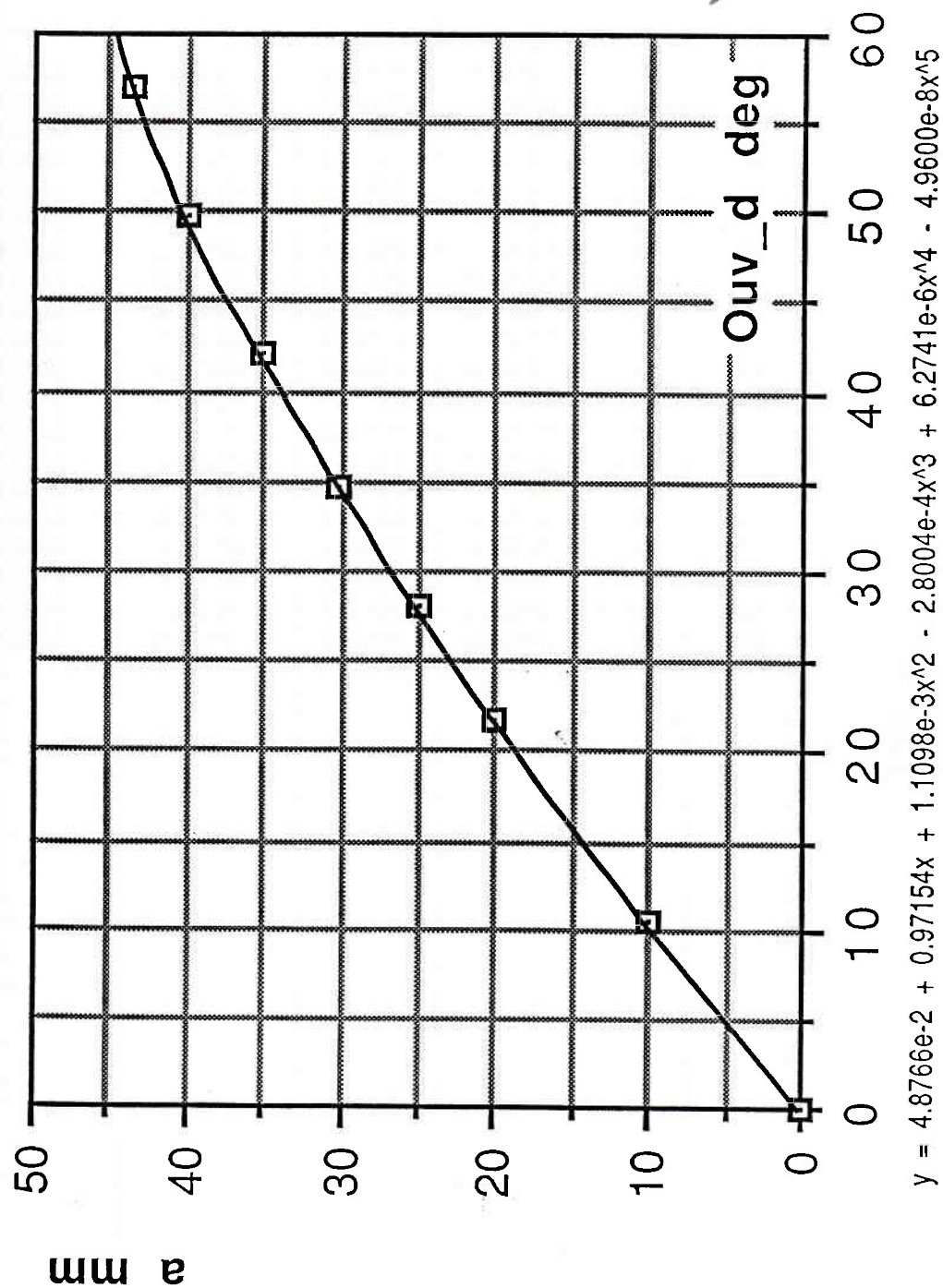


328-10-07 GABRIEL TERRA U.T.E.

Date:

19 mar 92

# 328 GABRIEL TERRA



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNEÉTALONNAGE DU COUPLE  
DE FROTTEMENT

| 328-00-13 GABRIEL TERRA |           |          |                    |                   |                    |               | Date: 30 MAR 92 |
|-------------------------|-----------|----------|--------------------|-------------------|--------------------|---------------|-----------------|
| Ordonnée                | Pente     | Masse    | Fréquence calculée | Fréquence mesurée | Écart de fréquence | Écart relatif |                 |
| [Hz]                    | [kg/kHz]  | [kg]     | [kHz]              | [kHz]             | [Hz]               | [o/oo]        |                 |
| Tif_ord                 | Tif_pente | Tif_etal | Tif_frdr           | Tif_freq          | Dtif_freq          | Dtif_rel      |                 |
| 4606                    | .91743    | 2.0035   | 2.3299             | 2.3295            | -.38               | -.17          |                 |
| 4606                    | .91743    | 2.0035   | 2.3299             | 2.3294            | -.47               | -.22          |                 |
| 4606                    | .91743    | 3.0075   | 3.4242             | 3.4244            | .17                | .05           |                 |
| 4606                    | .91743    | 3.0075   | 3.4242             | 3.4245            | .27                | .08           |                 |
| 4606                    | .91743    | 4.0115   | 4.5186             | 4.5191            | .51                | .12           |                 |
| 4606                    | .91743    | 4.0115   | 4.5186             | 4.5190            | .41                | .09           |                 |
| 4606                    | .91743    | 5.0155   | 5.6129             | 5.6133            | .35                | .06           |                 |
| 4606                    | .91743    | 5.0155   | 5.6129             | 5.6132            | .25                | .05           |                 |
| 4606                    | .91743    | 6.0195   | 6.7073             | 6.7071            | -.21               | -.03          |                 |
| 4606                    | .91743    | 6.0195   | 6.7073             | 6.7071            | -.21               | -.03          |                 |
| 4606                    | .91743    | 6.0195   | 6.7073             | 6.7071            | -.21               | -.03          |                 |
| 4606                    | .91743    | 6.0195   | 6.7073             | 6.7071            | -.21               | -.03          |                 |
| 4606                    | .91743    | 5.0155   | 5.6129             | 5.6128            | -.15               | -.03          |                 |
| 4606                    | .91743    | 5.0155   | 5.6129             | 5.6126            | -.35               | -.06          |                 |
| 4606                    | .91743    | 4.0115   | 4.5186             | 4.5188            | .21                | .05           |                 |
| 4606                    | .91743    | 4.0115   | 4.5186             | 4.5187            | .11                | .02           |                 |
| 4606                    | .91743    | 3.0075   | 3.4242             | 3.4243            | .07                | .02           |                 |
| 4606                    | .91743    | 3.0075   | 3.4242             | 3.4242            | -.03               | -.01          |                 |
| 4606                    | .91743    | 2.0035   | 2.3299             | 2.3298            | -.08               | -.03          |                 |
| 4606                    | .91743    | 2.0035   | 2.3299             | 2.3298            | -.08               | -.03          |                 |

pour ESR

Robert

pour CTE

M. M. M. M. M.

pour NP

P. M. M. M. M.

pour IMHEF

H. M. M. M. M.



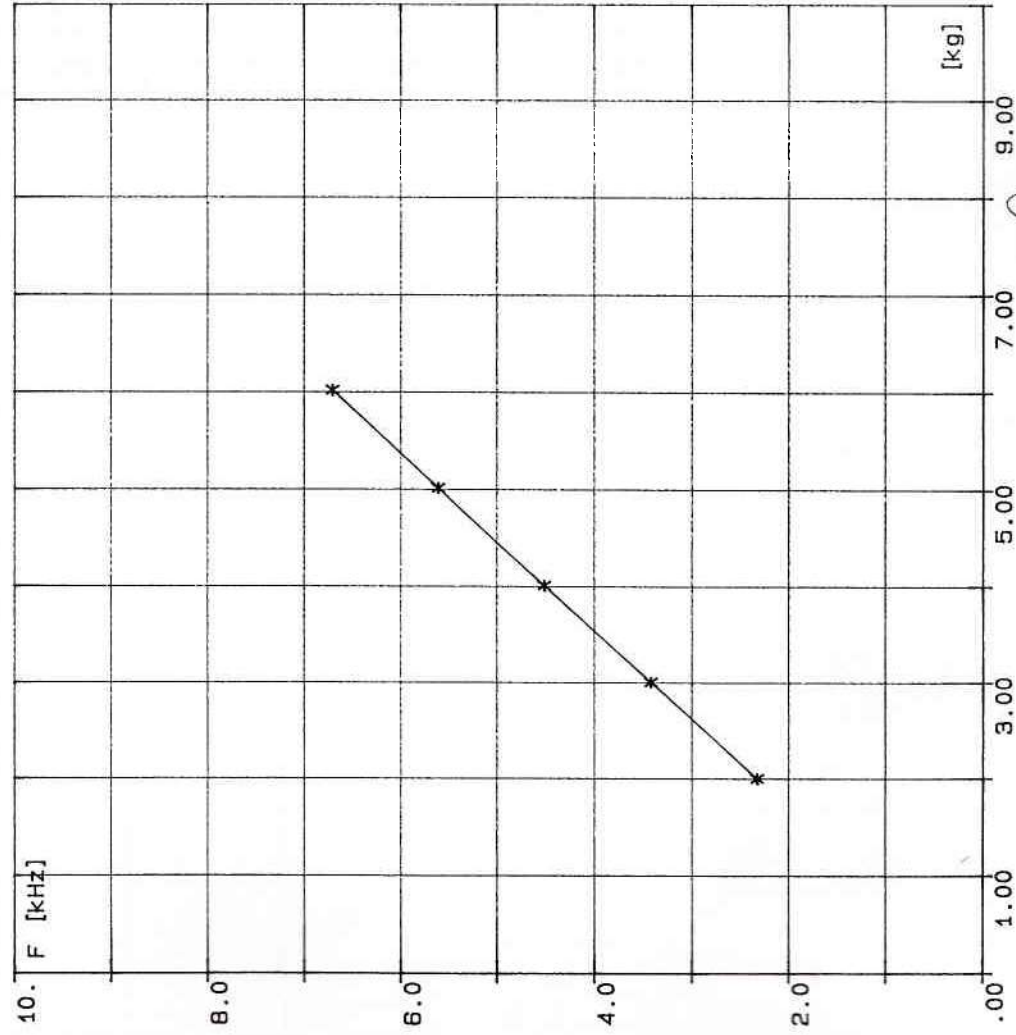
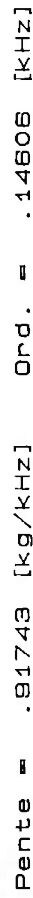
328-00-14 GABRIEL TERRA

# NEURPIC

**EPFL/IMHBP**

ETALONNAGE du couple de frottement (capteur HBM Z3H2 No B21813)

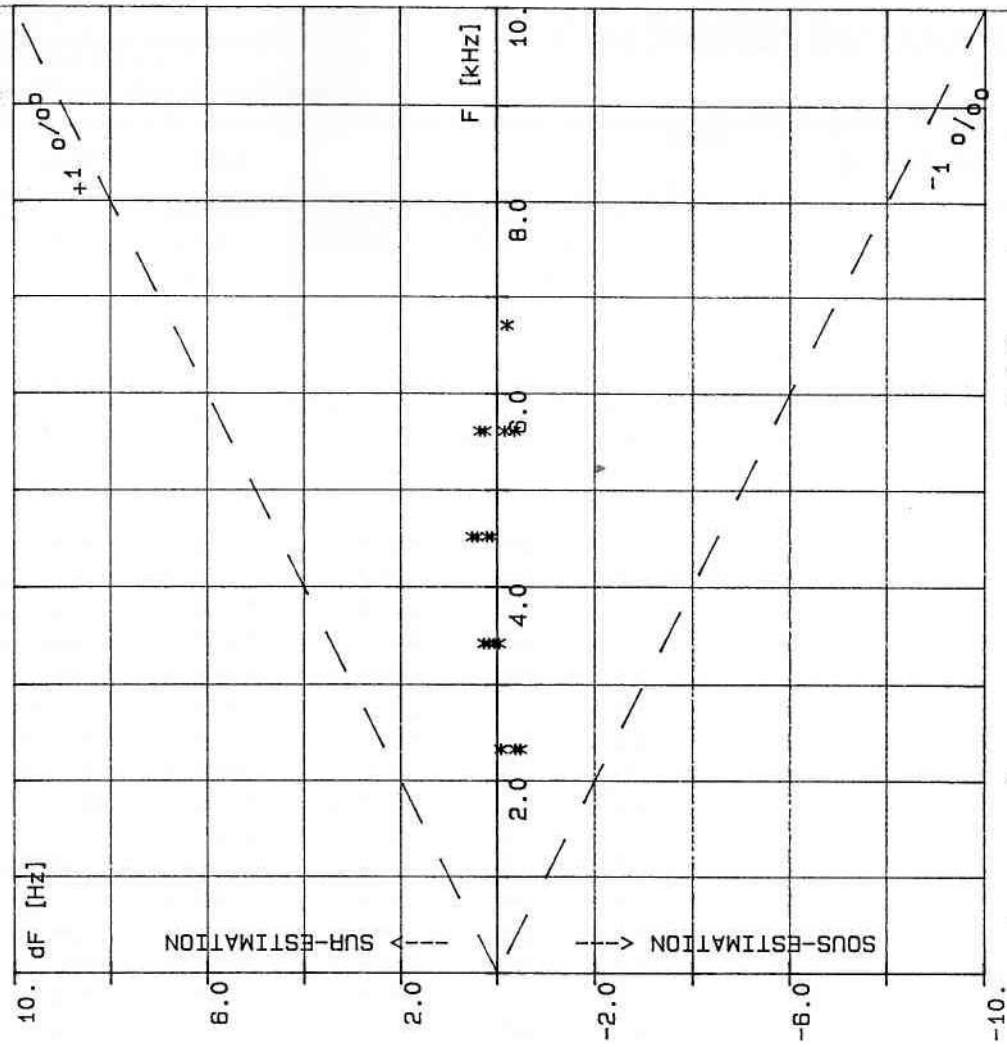
30 MAR 92



how  
Eof  
Robert

27th Nov 1944

9.00



from VP Powell

for  $1 \leq i \leq n$

W. C. C.

**Essai:**

328-00-15

GABRIEL TERRA

Date:

30 MAR 92

| Ordonnée | Pente    | Masse    | Fréquence calculée | Fréquence mesurée | Écart de fréquence | Écart relatif |
|----------|----------|----------|--------------------|-------------------|--------------------|---------------|
| [kHz]    | [kg/kHz] | [kg]     | [kHz]              | [kHz]             | [Hz]               | [o/oo]        |
| C_ord    | C_pente  | C_etal   | C_frdr             | C_freq            | Dc_freq            | Dcf_rel       |
| .19442   | 24.80748 | 40.1847  | 1.8143             | 1.8135            | -.78               | -.48          |
| .19442   | 24.80748 | 40.1847  | 1.8143             | 1.8133            | -.98               | -.61          |
| .19442   | 24.80748 | 60.1847  | 2.6205             | 2.6198            | -.69               | -.28          |
| .19442   | 24.80748 | 60.1847  | 2.6205             | 2.6196            | -.89               | -.37          |
| .19442   | 24.80748 | 80.1847  | 3.4267             | 3.4264            | -.30               | -.09          |
| .19442   | 24.80748 | 80.1847  | 3.4267             | 3.4260            | -.70               | -.22          |
| .19442   | 24.80748 | 110.1847 | 4.6360             | 4.6362            | .19                | .04           |
| .19442   | 24.80748 | 110.1847 | 4.6360             | 4.6360            | -.01               | -.00          |
| .19442   | 24.80748 | 130.1847 | 5.4422             | 5.4420            | -.22               | -.04          |
| .19442   | 24.80748 | 130.1847 | 5.4422             | 5.4417            | -.52               | -.10          |
| .19442   | 24.80748 | 130.1847 | 5.4422             | 5.4416            | -.62               | -.12          |
| .19442   | 24.80748 | 130.1847 | 5.4422             | 5.4418            | -.42               | -.08          |
| .19442   | 24.80748 | 110.1847 | 4.6360             | 4.6370            | .99                | .22           |
| .19442   | 24.80748 | 110.1847 | 4.6360             | 4.6368            | .79                | .18           |
| .19442   | 24.80748 | 80.1847  | 3.4267             | 3.4274            | .70                | .22           |
| .19442   | 24.80748 | 80.1847  | 3.4267             | 3.4269            | .20                | .06           |
| .19442   | 24.80748 | 60.1847  | 2.6205             | 2.6222            | 1.71               | .70           |
| .19442   | 24.80748 | 60.1847  | 2.6205             | 2.6217            | 1.21               | .50           |
| .19442   | 24.80748 | 40.1847  | 1.8143             | 1.8147            | .42                | .26           |
| .19442   | 24.80748 | 40.1847  | 1.8143             | 1.8142            | -.08               | -.05          |

from NP  
Pruitt

pour IMHEF

*Handwritten signature*

for Ed Robert

for UTE

Normalind

328-00-16 GABRIEL TERRA

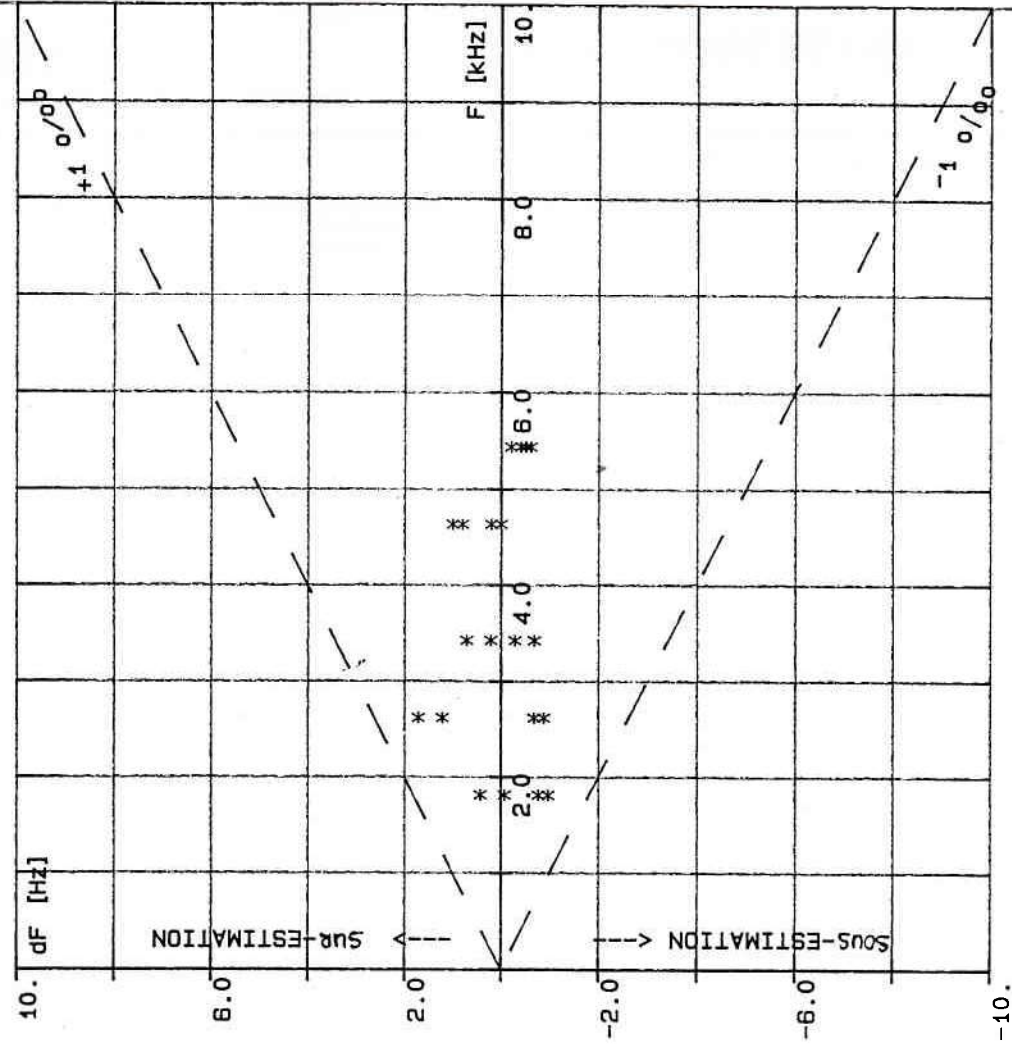
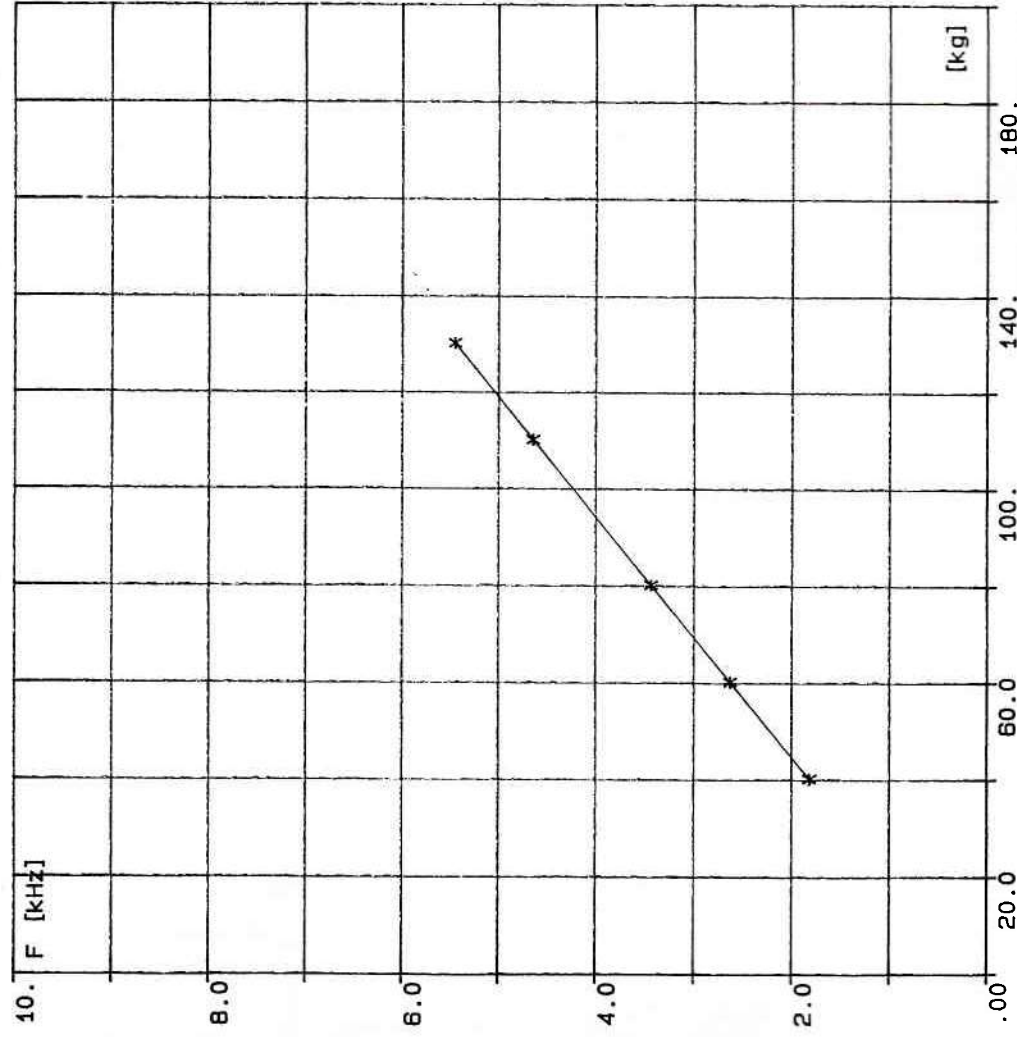
NEYRPIC

EPFL/IMHEF

ETALONNAGE du couple stand 2 (capteurs HBM No9990 et 10009)

30 MAR 92

Pente = 24.80748 [kg/kHz] Ord. = .19442 [kHz]



bon EDF

Robert

Mr de Franck

pour NT

pour IMHEF

pour IMHEF

**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

## ÉTALONNAGE DE LA CHUTE

| 328-00-17 GABRIEL TERRA |            |         |                    |                   |                    |               | Date: 30 MAR 92   |
|-------------------------|------------|---------|--------------------|-------------------|--------------------|---------------|---|
| Donnée                  | Pente      | Hauteur | Fréquence calculée | Fréquence mesurée | Écart de fréquence | Écart relatif |   |
|                         | [m.Hg/kHz] | [m.Hg]  | [kHz]              | [kHz]             | [Hz]               | [o/oo]        |   |
|                         | H_pente    | H_etal  | H_fldr             | H_freq            | Dh_freq            | Dhf_rel       |   |
| .11930                  | .08170     | .3979   | 4.9896             | 4.9860            | -3.56              | -.73          | Température: 18.8 (°C)<br>Mu-piézo=998.5<br>Dmug-h=123026.7 |
| .11930                  | .08170     | .3980   | 4.9908             | 4.9865            | -4.28              | -.88          |   |
| .11930                  | .08170     | .4390   | 5.4920             | 5.4895            | -2.51              | -.47          |   |
| .11930                  | .08170     | .4389   | 5.4914             | 5.4897            | -1.69              | -.32          |   |
| .11930                  | .08170     | .4774   | 5.9626             | 5.9621            | -.53               | -.09          |   |
| .11930                  | .08170     | .4774   | 5.9626             | 5.9624            | -.23               | -.04          |   |
| .11930                  | .08170     | .5183   | 6.4632             | 6.4628            | -.44               | -.07          |   |
| .11930                  | .08170     | .5182   | 6.4626             | 6.4627            | .07                | .01           |   |
| .11930                  | .08170     | .5572   | 6.9394             | 6.9379            | -1.47              | -.22          |   |
| .11930                  | .08170     | .5572   | 6.9394             | 6.9379            | -1.47              | -.22          |   |
| .11930                  | .08170     | .5572   | 6.9394             | 6.9379            | -1.47              | -.22          |   |
| .11930                  | .08170     | .5572   | 6.9394             | 6.9380            | -1.37              | -.20          |   |
| .11930                  | .08170     | .5378   | 6.7019             | 6.7054            | 3.48               | .53           |   |
| .11930                  | .08170     | .5378   | 6.7019             | 6.7055            | 3.58               | .54           |   |
| .11930                  | .08170     | .4978   | 6.2123             | 6.2169            | 4.58               | .75           |   |
| .11930                  | .08170     | .4978   | 6.2123             | 6.2171            | 4.78               | .78           |   |
| .11930                  | .08170     | .4580   | 5.7252             | 5.7293            | 4.12               | .74           |   |
| .11930                  | .08170     | .4580   | 5.7252             | 5.7296            | 4.42               | .79           |   |
| .11930                  | .08170     | .4181   | 5.2368             | 5.2402            | 3.40               | .66           |   |
| .11930                  | .08170     | .4182   | 5.2374             | 5.2404            | 2.98               | .58           |   |
| .11930                  | .08170     | .3984   | 4.9957             | 4.9980            | 2.32               | .48           |   |
| .11930                  | .08170     | .3984   | 4.9957             | 4.9982            | 2.52               | .52           |   |

pour EDF   
 pour NP

pour U.T.E.   
 pour IMHEF



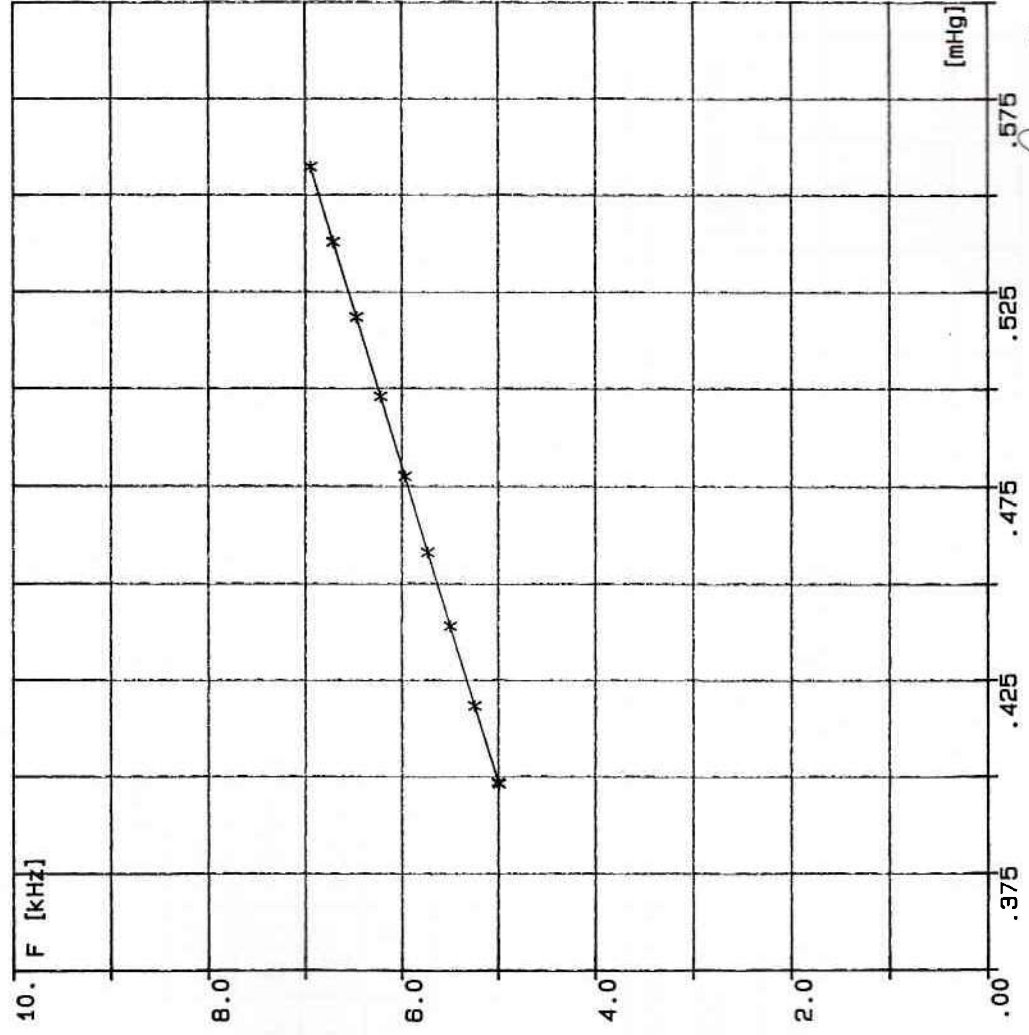
328-00-18 GABRIEL TERRA NEYRPIC

EPFL/IMHEF

ETALONNAGE de la chute (capteur HBM PD1 No 2944)

30 MAR 92

Pente = .08170 [mHg/kHz] Ord. = .11930 [kHz]



bon 25

Robert

pour 25 3/4

0.97

10. dF [Hz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0

-8.0

-10.0

10. F [kHz]

8.0

6.0

4.0

2.0

0.0

-2.0

-4.0

-6.0



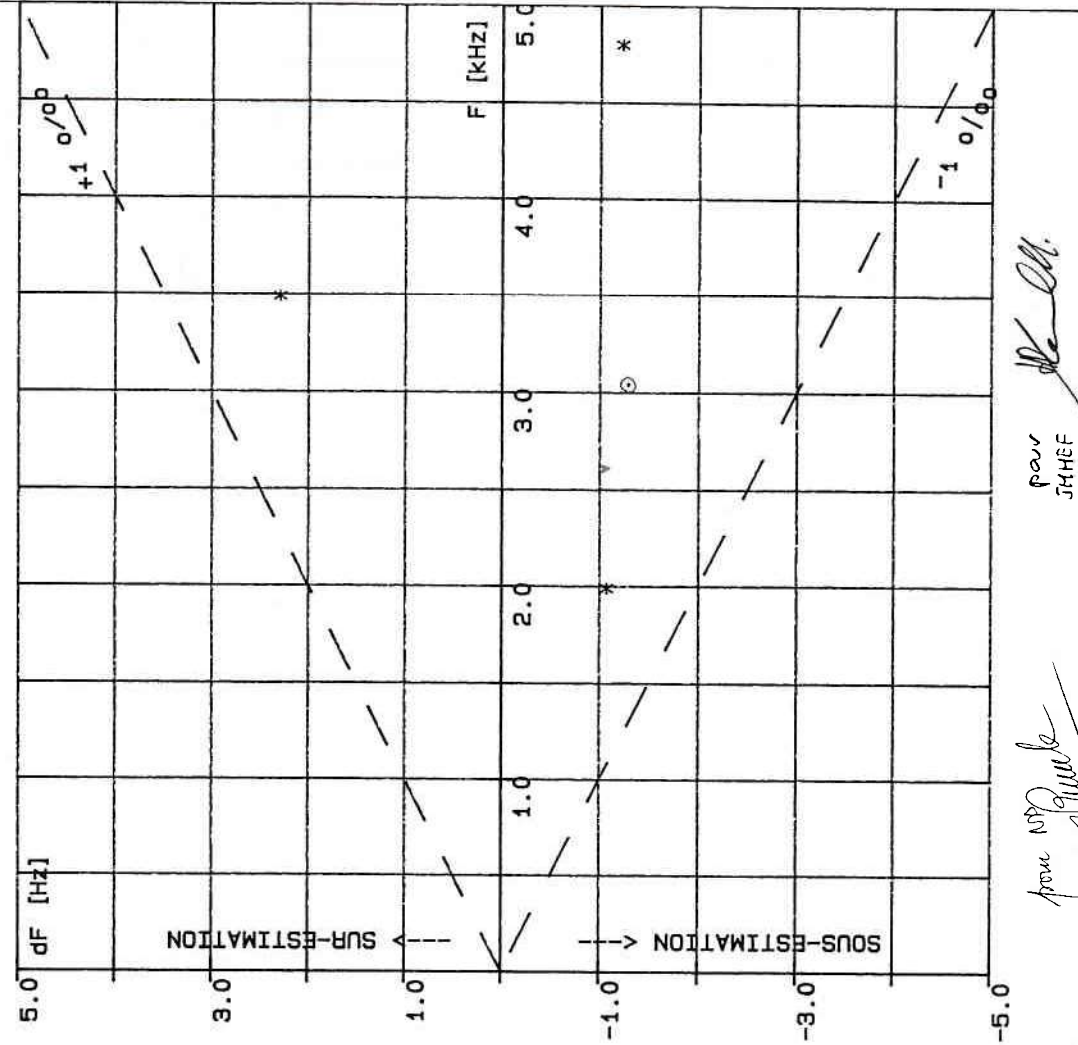
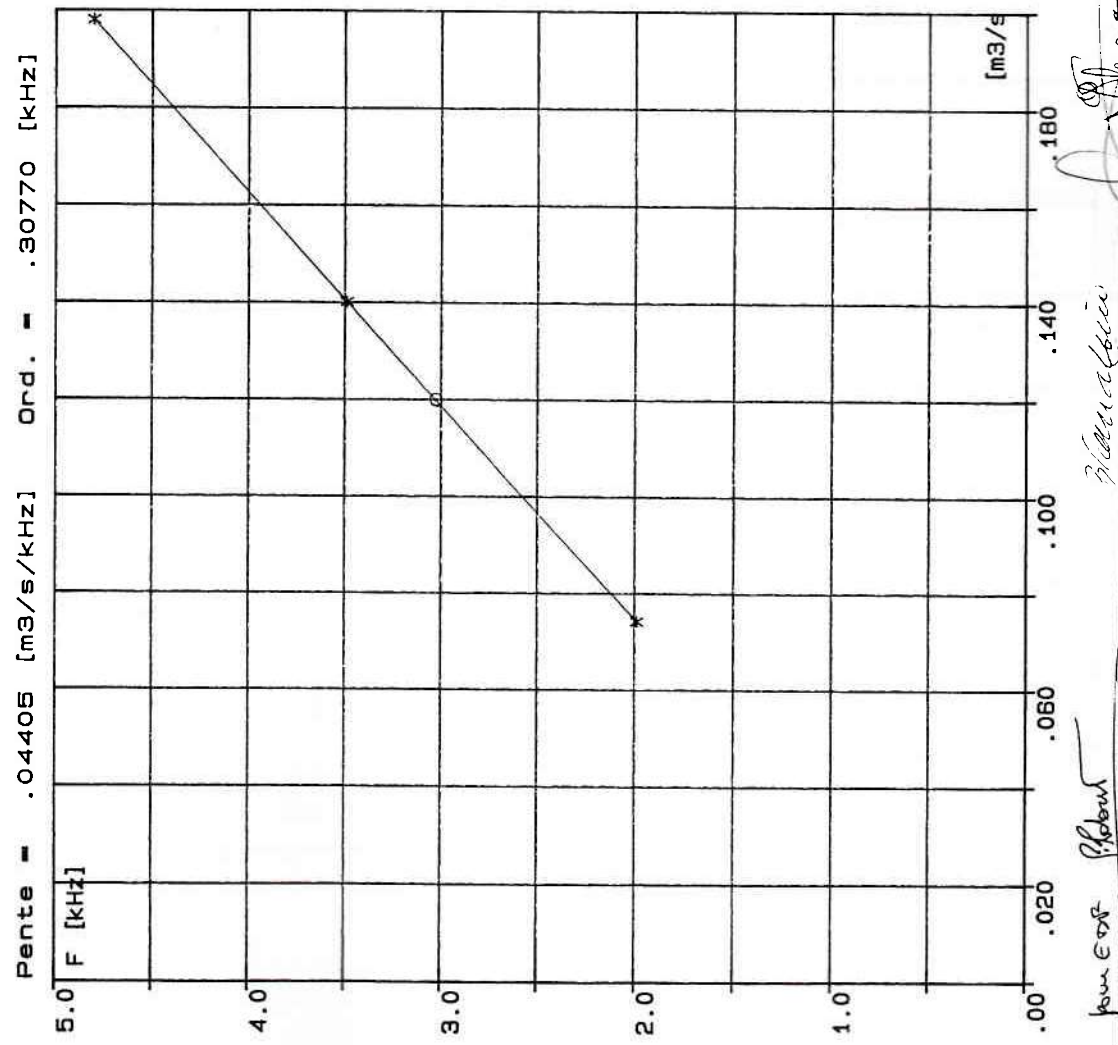


Essai: 328-00-20 GABRIEL TERRA Date: 30 MAR 92

| N°<br>[ - ]  | Limnimètre 1    |                  | Limn.<br>sup.<br>[ - ] | Limnimètre sup. |                  | Température<br>eau - bassin<br>[°C] | Correction<br>de la cote<br>[mm] | Volume<br>supérieur<br>[dm³] | Volume mort<br>[dm³] | Correction de<br>volume<br>[dm³] | Fréquence<br>mesurée<br>[kHz] |                     |                 |                  |                   | Écart<br>relatif<br>[c/oo]<br>Dq_freq<br>Q_freq-Q_ord |
|--|-----------------|------------------|------------------------|-----------------|------------------|-------------------------------------|----------------------------------|------------------------------|----------------------|----------------------------------|-------------------------------|---------------------|-----------------|------------------|-------------------|---|
|  | Butée<br>[mm]   | Lecture<br>[mm]  |                        | Butée<br>[mm]   | Lecture<br>[mm]  |                                     |                                  |                              |                      |                                  | Temps<br>[s]                  | Impulsions<br>[ - ] | Débit<br>[m³/s] | Pente<br>[m%kHz] | Ordonnée<br>[kHz] | Fréquence<br>calculée<br>[kHz]                        |
| NQ   | ZB1             | ZL1              | LI                     | ZBS             | ZLS              | TET                                 | CZS                              | VZS                          | VZ1                  | CVT                              |                               | NIM                 | Q_etal          | Q_pente          | Q_ord             | Q_freq  |
|  | Pointe (1)      | Z1               |                        | Pointe (LI)     | ZS               |                                     | ZCO                              |                              | DVT                  | VCO                              | DET                           |                     |                 |                  |                   | Q_frdr  |
| 1  | 450.60<br>37.96 | 208.40<br>204.24 | 2                      | 450.40<br>38.19 | 324.00<br>88.21  | 13.6                                | -1.125<br>88.08                  | 71891.7                      | 3749.8<br>68141.9    | -7.85<br>68134.0                 | 918541.                       | 1828296.            | .07418          | .04405           | .3077             | 1.9904<br>1.9915                                      |
| 2  | 450.60<br>37.96 | 301.10<br>111.54 | 2                      | 450.40<br>38.19 | 303.30<br>108.91 | 13.7                                | -1.121<br>108.79                 | 72340.2                      | 1741.7<br>70598.5    | -7.87<br>70590.6                 | 503935.                       | 1758628.            | .14008          | .04405           | .3077             | 3.4898<br>3.4875                                      |
| 3  | 450.60<br>37.96 | 219.70<br>192.94 | 2                      | 450.40<br>38.19 | 286.70<br>125.51 | 13.8                                | -1.117<br>125.39                 | 72699.9                      | 3505.0<br>69194.8    | -7.48<br>69187.4                 | 349358.                       | 1677629.            | .19804          | .04405           | .3077             | 4.8020<br>4.8033                                      |
| GAMME : 1<br>Ordonnée = zéro de la caractéristique + 0.00943 = 0.3077<br>(0.29827) |                 |                  |                        |                 |                  |                                     |                                  |                              |                      |                                  |                               |                     |                 |                  |                   |   |

001 ( ) 200-0122 328-00-20 pour NP ( ) 10-10









ATMOSPHERIC AIR QUALITY  
ANALYSIS

MAINTENANCE IIII HHHHHH

Essai: 328-00-22

GABRIEL TERRA

10/08

31 MAR 09

| N°<br>[ - ]                                       | Limnimètre 1    |                  | Limn.<br>sup.<br>[ - ] | Limnimètre sup. |                  | Température<br>eau - bassin<br>[°C] | Correction<br>de la cote<br>[mm] | Volume<br>supérieur<br>[dm³] | Volume mort<br>[dm³] | Correction de<br>volume<br>[dm³] | Fréquence<br>mesurée<br>[kHz] |                     |                 |                   |                   |                                | Écart<br>relatif<br>[‰] | Écart<br>relatif<br>[‰] |        |         |  |  |  |
|---|-----------------|------------------|------------------------|-----------------|------------------|-------------------------------------|----------------------------------|------------------------------|----------------------|----------------------------------|-------------------------------|---------------------|-----------------|-------------------|-------------------|--------------------------------|-------------------------|-------------------------|--------|---------|--|--|--|
|   | Butée<br>[mm]   | Lecture<br>[mm]  |                        | Butée<br>[mm]   | Lecture<br>[mm]  |                                     |                                  |                              |                      |                                  | Temps<br>[s]                  | Impulsions<br>[ - ] | Débit<br>[m³/s] | Pente<br>[m‰/kHz] | Ordonnée<br>[kHz] | Fréquence<br>calculée<br>[kHz] |                         |                         | Q_freq | Dq_freq |  |  |  |
| NQ  | ZB1             | ZL1              | LI                     | ZBS             | ZLS              | TET                                 | CZS                              | VZS                          | VZ1                  | CVT                              | DET                           | NIM                 | Q_etal          | Q_pente           | Q_ord             |                                |                         |                         |        |         |  |  |  |
|   | Pointe (1)      | Z1               |                        | Pointe (LI)     | ZS               |                                     | ZCO                              |                              | DVT                  | VCO                              |                               |                     |                 |                   |                   |                                |                         |                         |        |         |  |  |  |
| 1   | 450.60<br>37.96 | 212.80<br>199.84 | 2                      | 450.40<br>38.19 | 275.80<br>136.41 | 13.8                                | -117<br>136.29                   | 72936.0                      | 3654.5<br>69281.5    | -7.48<br>69274.0                 | 293031.                       | 237639.             | .23641          | .30119            | .02675            | .8110<br>.8117                 |                         |                         |        |         |  |  |  |
| 2   | 450.60<br>37.96 | 209.70<br>202.94 | 2                      | 450.40<br>38.19 | 236.50<br>175.71 | 14.0                                | -109<br>175.60                   | 73786.0                      | 3721.7<br>70064.3    | -7.06<br>70057.2                 | 180211.                       | 237424.             | .38875          | .30119            | .02675            | 1.3175<br>1.3175               |                         |                         |        |         |  |  |  |
| 3   | 450.60<br>37.96 | 213.10<br>199.54 | 2                      | 450.40<br>38.19 | 177.00<br>235.21 | 14.0                                | -109<br>235.10                   | 75074.2                      | 3648.0<br>71426.2    | -7.20<br>71419.0                 | 119542.                       | 240547.             | .59744          | .30119            | .02675            | 2.0122<br>2.0103               |                         |                         |        |         |  |  |  |
| 4   | 450.60<br>37.96 | 208.40<br>204.24 | 3                      | 450.00<br>37.92 | 160.90<br>251.18 | 14.0                                | -209<br>250.97                   | 139414.9                     | 3749.8<br>135665.0   | -13.67<br>135651.4               | 170395.                       | 454733.             | .79610          | .30119            | .02675            | 2.6687<br>2.6699               |                         |                         |        |         |  |  |  |
| GAMME : 2   |                 |                  |                        |                 |                  |                                     |                                  |                              |                      |                                  |                               |                     |                 |                   |                   |                                |                         |                         |        |         |  |  |  |
| Ordonnée = zéro de la caractéristique - (0.02787) |                 |                  |                        |                 |                  |                                     |                                  |                              |                      |                                  |                               |                     |                 |                   |                   |                                |                         |                         |        |         |  |  |  |

bas e of Plateau

bas e of Plateau

bas e of Plateau

bas e of Plateau

bas e of Plateau

bas e of Plateau

bas e of Plateau

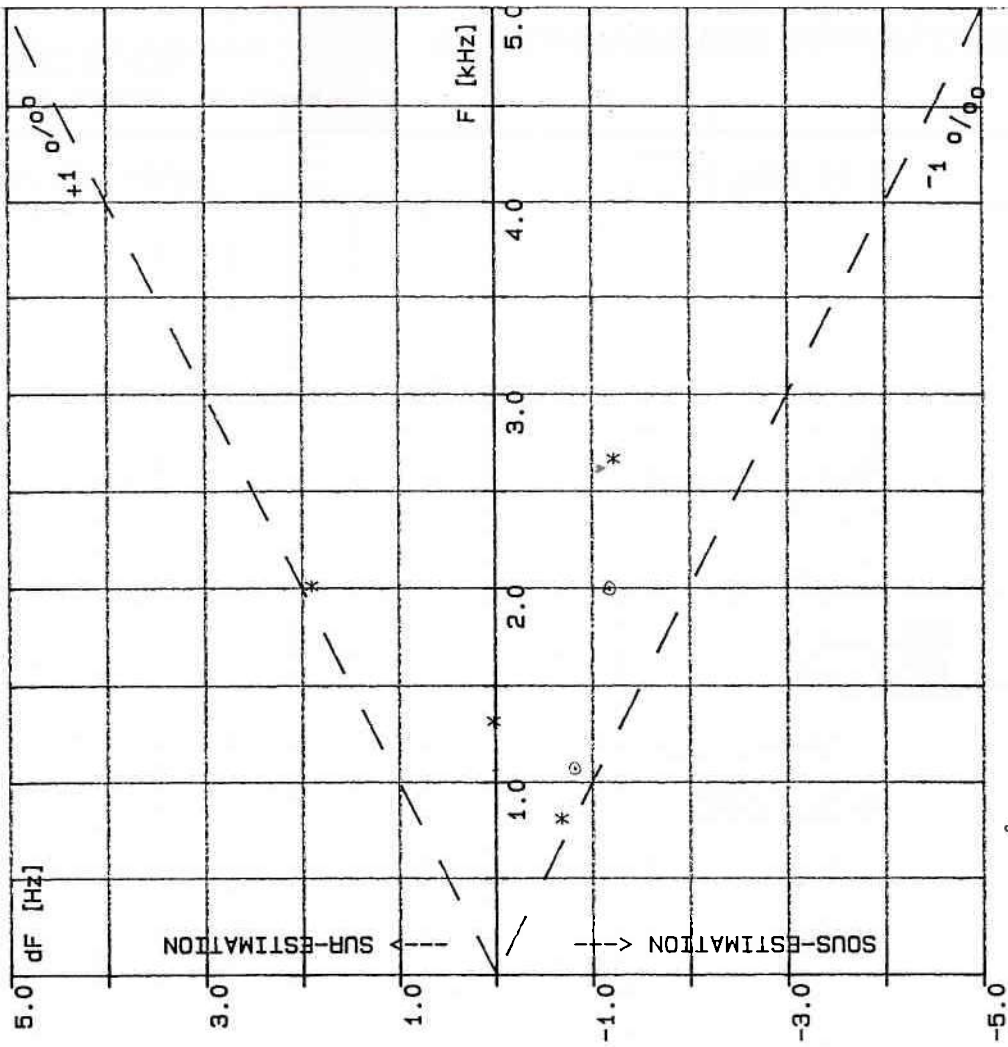
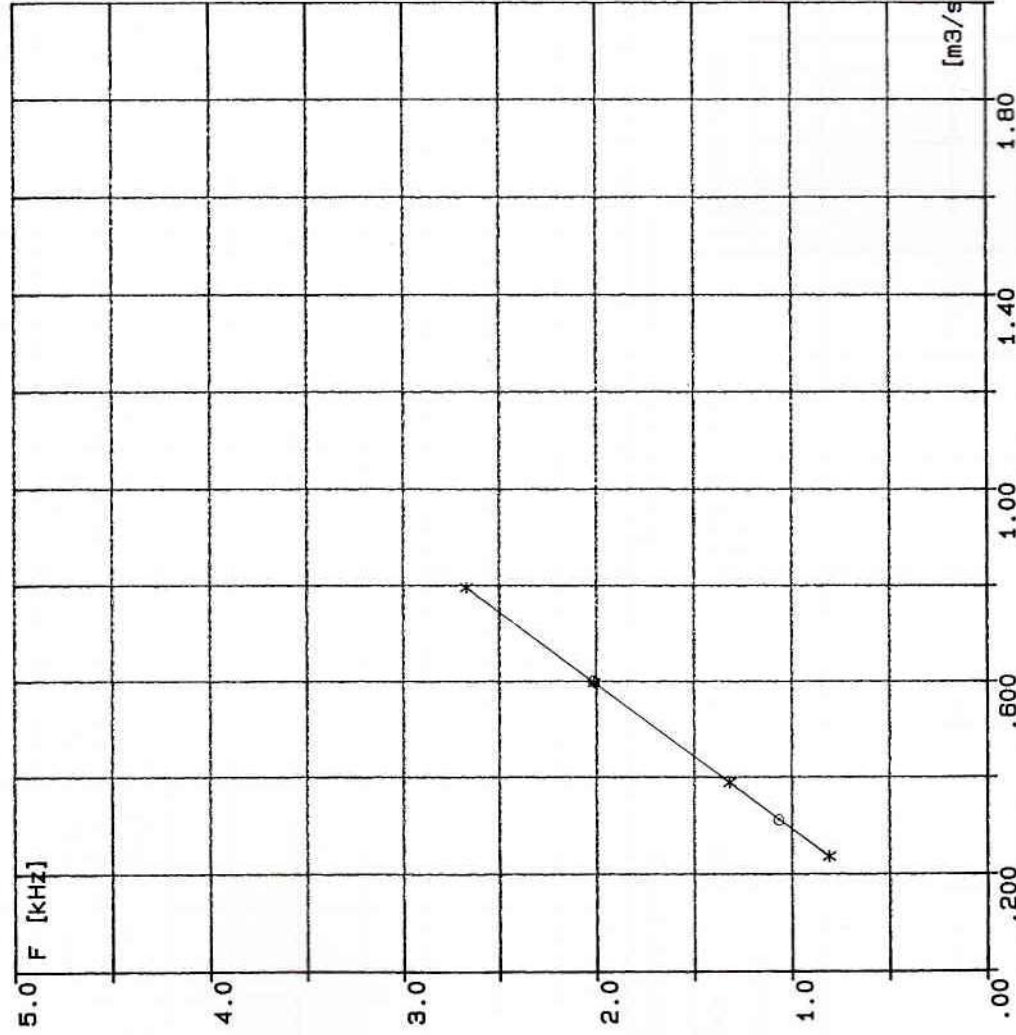
328-00-23 GABRIEL TERRA NEYRPIC

EPFL/IMHEF

ETALONNAGE du debitmetre electromagnetique. TURBINE, gamme 2

31 MAR 92

Pente = .30119 [m3/s/kHz] Ord. = .02875 [kHz]



pour EOT *[Signature]* 31/03/92 *[Signature]*

pour IMHEF *[Signature]*

Essai:

328-00-25 GABRIEL TERRA

Date: 03 AVR 92

1912

Carroll

TURBINE

**Sons:**

[illegible]





58811608, 84422197, 0662

[illegible]

Essai: 328-00-26

GABRIEL TERRA

**Date**

03 AVR 92

| N°<br>[-]  | Limnimètre 1    |                  | Limn. sup.<br>[-] | Limnimètre sup. |                  | Température eau - Bassin<br>[°C] | Correction de la cote<br>[mm] | Volume supérieur<br>[dm³] | Volume mort<br>[dm³] | Correction de volume<br>[dm³] | Temps<br>[s] | Impulsions<br>[-] | Débit<br>[m³/s] | Pente<br>[m³/kHz] | Ordonnée<br>[kHz] | Fréquence calculée<br>[kHz] | Écart de fréquence<br>[Hz] | Écart relatif<br>[o/oo]<br>Dq_freq<br>Q_freq-Q_ord |
|--|-----------------|------------------|-------------------|-----------------|------------------|----------------------------------|-------------------------------|---------------------------|----------------------|-------------------------------|--------------|-------------------|-----------------|-------------------|-------------------|-----------------------------|----------------------------|--|
|  | Bulée<br>[mm]   | Lecture<br>[mm]  |                   | Bulée<br>[mm]   | Lecture<br>[mm]  |                                  |                               |                           |                      |                               |              |                   |                 |                   |                   |                             |                            |  |
| NQ   | ZB1             | ZL1              | LI                | ZBS             | ZLS              | TET                              | CZS                           | VZS                       | VZ1                  | CVT                           | DET          | NIM               | Q_etal          | Q_pente           | Q_ord             | Q_freq                      | Dq_freq                    | Dqf_rei  |
|  | Pointe (1)      | Z1               |                   | Pointe (LI)     | ZS               |                                  | ZCO                           |                           | DVT                  | VCO                           |              |                   |                 |                   |                   |                             |                            |  |
| 1  | 450.50<br>37.96 | 210.20<br>202.34 | 2                 | 450.30<br>38.19 | 257.60<br>154.51 | 14.8                             | -0.078<br>154.43              | 73328.4                   | 3708.7<br>69619.7    | -5.02<br>69614.7              | 226384.      | 236991.           | .30751          | .30119            | .0267             | 1.0469<br>1.0476            | -.79                       | -.77   |
| 2  | 450.50<br>37.96 | 222.70<br>189.84 | 2                 | 450.30<br>38.19 | 183.00<br>229.11 | 14.8                             | -0.078<br>229.03              | 74942.8                   | 3437.9<br>71504.9    | -5.15<br>71499.8              | 119438.      | 240442.           | .59864          | .30119            | .0267             | 2.0131<br>2.0142            | -1.13                      | -.57   |
| GAMME : 2  |                 |                  |                   |                 |                  |                                  |                               |                           |                      |                               |              |                   |                 |                   |                   |                             |                            |  |
| 1  | 450.50<br>37.96 | 229.00<br>183.54 | 2                 | 450.30<br>38.19 | 311.70<br>100.41 | 14.8                             | -0.078<br>100.33              | 72157.0                   | 3301.4<br>68855.6    | -4.96<br>68850.6              | 578377.      | 1738096.          | .11904          | .04405            | .3039             | 3.0051<br>3.0063            | -1.16                      | -.43   |
| GAMME : 1  |                 |                  |                   |                 |                  |                                  |                               |                           |                      |                               |              |                   |                 |                   |                   |                             |                            |  |
| <div style="display: flex; justify-content: space-between;"> <div>pour VTE</div> <div>pour JMHF</div> <div>pour EDF</div> </div> |                 |                  |                   |                 |                  |                                  |                               |                           |                      |                               |              |                   |                 |                   |                   |                             |                            |  |

**Essai:**

328-00-27

GABRIEL TERRA

Date:

03 AVR 92

| Ordonnée | Pente      | Hauteur | Fréquence<br>calculée | Fréquence<br>mesurée | Écart de<br>fréquence | Écart<br>relatif |
|----------|------------|---------|-----------------------|----------------------|-----------------------|------------------|
| [kHz]    | [m.Hg/kHz] | [m.Hg]  | [kHz]                 | [kHz]                | [Hz]                  | [o/oo]           |
| S_ord    | S_pente    | S_etal  | S_frdr                | S_freq               | Ds_freq               | Dsf_rel          |
| .1284    | .08299     | .31940  | 3.9771                | 3.9734               | -3.66                 | -.95             |
| .1284    | .08299     | .31940  | 3.9771                | 3.9744               | -2.66                 | -.69             |
| .1284    | .08299     | .39850  | 4.9302                | 4.9308               | .62                   | .13              |
| .1284    | .08299     | .39855  | 4.9308                | 4.9311               | .31                   | .07              |
| .1284    | .08299     | .47840  | 5.8930                | 5.8927               | -.25                  | -.04             |
| .1284    | .08299     | .47840  | 5.8930                | 5.8927               | -.25                  | -.04             |
| .1284    | .08299     | .55775  | 6.8491                | 6.8464               | -2.69                 | -.40             |
| .1284    | .08299     | .55775  | 6.8491                | 6.8464               | -2.69                 | -.40             |
| .1284    | .08299     | .55775  | 6.8491                | 6.8464               | -2.69                 | -.40             |
| .1284    | .08299     | .55775  | 6.8491                | 6.8464               | -2.69                 | -.40             |
| .1284    | .08299     | .51860  | 6.3773                | 6.3814               | 4.05                  | .65              |
| .1284    | .08299     | .51860  | 6.3773                | 6.3815               | 4.15                  | .66              |
| .1284    | .08299     | .43830  | 5.4098                | 5.4145               | 4.74                  | .90              |
| .1284    | .08299     | .43830  | 5.4098                | 5.4147               | 4.94                  | .93              |
| .1284    | .08299     | .35670  | 4.4265                | 4.4277               | 1.19                  | .28              |
| .1284    | .08299     | .35670  | 4.4265                | 4.4280               | 1.49                  | .35              |
| .1284    | .08299     | .32020  | 3.9867                | 3.9862               | -.50                  | -.13             |
| .1284    | .08299     | .32020  | 3.9867                | 3.9864               | -.30                  | -.08             |

Température: 18.2 (°C)

Mu-piézo=998.6

Dmug-S=123039.9

Pen VTE

low EDF

12

Wm. C. C.

from NP  
Pueck

pour IMMEE

JP/LH

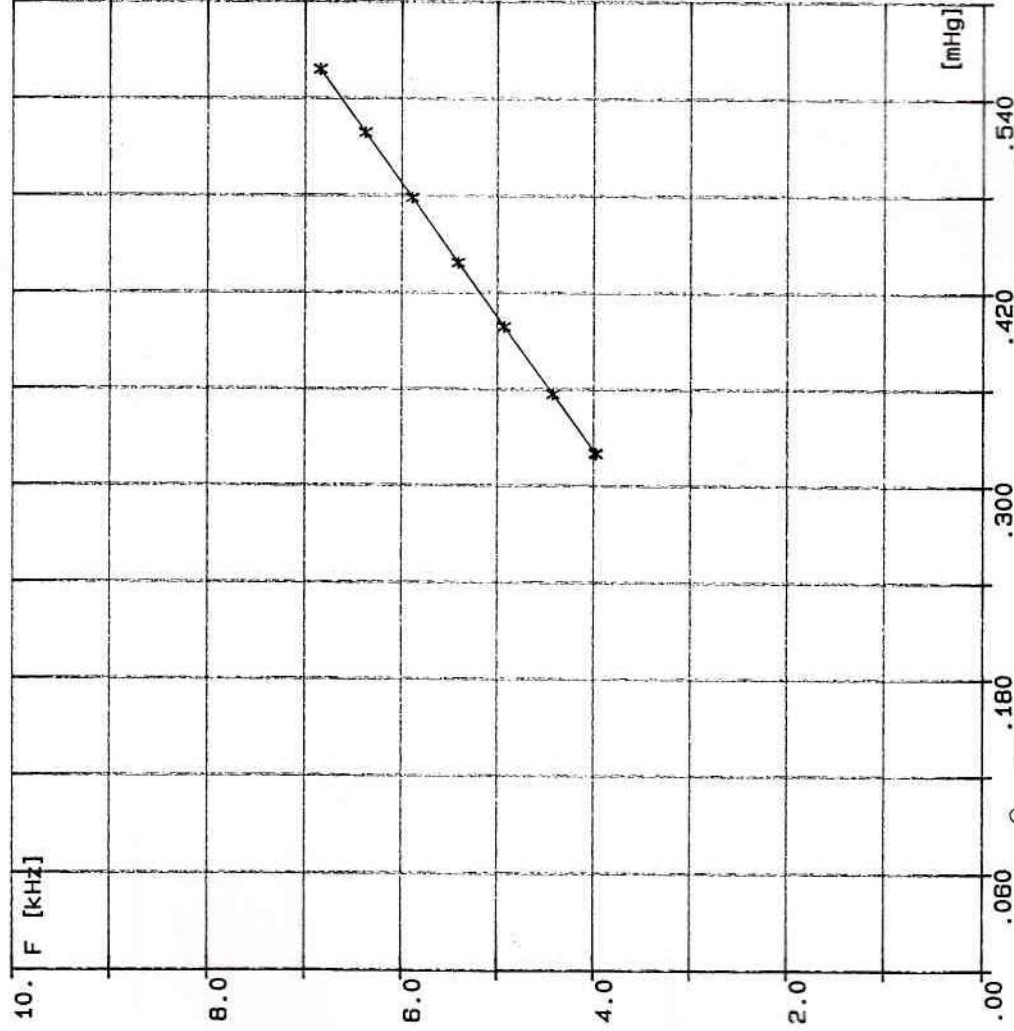
328-00-28 GABRIEL TERRA NEYRPIC

EPFL/IMHEF

ETALONNAGE du sigma (capteur HBM PD1 No 20729), gamme 1

03 AVR 92

Pente = .06299 [mHg/kHz] Ord. = .12840 [kHz]

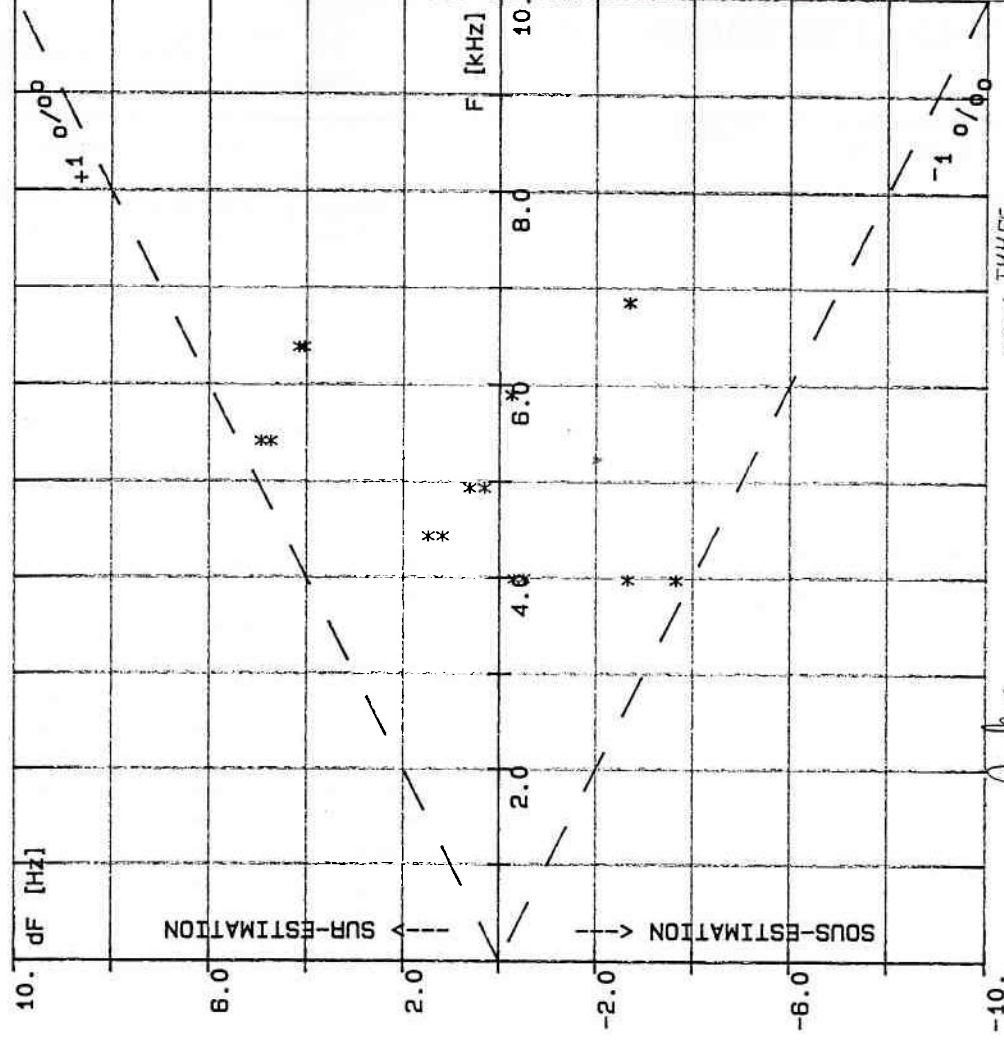


Per VTE *[Signature]*

*[Signature]*

pour EDF *[Signature]*

10. dF [Hz]



pour SF *[Signature]*

pour IMHEF

*[Signature]*

**IMHEF**

INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

**ÉTALONNAGE DE LA CHUTE**

| Essai: 328-00-29 GABRIEL TERRA |            |         |                    |                   |                    |               | Date: 06 AVR 92   |
|--------------------------------|------------|---------|--------------------|-------------------|--------------------|---------------|---|
| Ordonnée                       | Pente      | Hauteur | Fréquence calculée | Fréquence mesurée | Écart de fréquence | Écart relatif |   |
| [kHz]                          | [m.Hg/kHz] | [m.Hg]  | [kHz]              | [kHz]             | [Hz]               | [o/oo]        |   |
| H_ord                          | H_pente    | H_etal  | H_frdr             | H_freq            | Dh_freq            | Dhf_rel       |   |
| .11040                         | .08162     | .0816   | 1.1102             | 1.1095            | -.67               | -.67          |   |
| .11040                         | .08162     | .0817   | 1.1114             | 1.1108            | -.60               | -.60          | Température: 19.2 (°C)<br>Mu-piézo=998.4<br>Dmug-H=123017.9 |
| .11040                         | .08162     | .1595   | 2.0646             | 2.0635            | -1.11              | -.57          |   |
| .11040                         | .08162     | .1595   | 2.0646             | 2.0632            | -1.41              | -.72          |   |
| .11040                         | .08162     | .2386   | 3.0337             | 3.0333            | -.44               | -.15          |   |
| .11040                         | .08162     | .2386   | 3.0337             | 3.0333            | -.44               | -.15          |   |
| .11040                         | .08162     | .2386   | 3.0337             | 3.0335            | -.24               | -.08          |   |
| .11040                         | .08162     | .2386   | 3.0337             | 3.0337            | -.04               | -.01          |   |
| .11040                         | .08162     | .1987   | 2.5449             | 2.5467            | 1.81               | .74           |   |
| .11040                         | .08162     | .1988   | 2.5461             | 2.5470            | .89                | .36           |   |
| .11040                         | .08162     | .1196   | 1.5757             | 1.5766            | .85                | .58           |   |
| .11040                         | .08162     | .1196   | 1.5757             | 1.5766            | .85                | .58           |   |
| .11040                         | .08162     | .0790   | 1.0783             | 1.0786            | .29                | .29           |   |
| .11040                         | .08162     | .0791   | 1.0795             | 1.0798            | .26                | .27           |   |



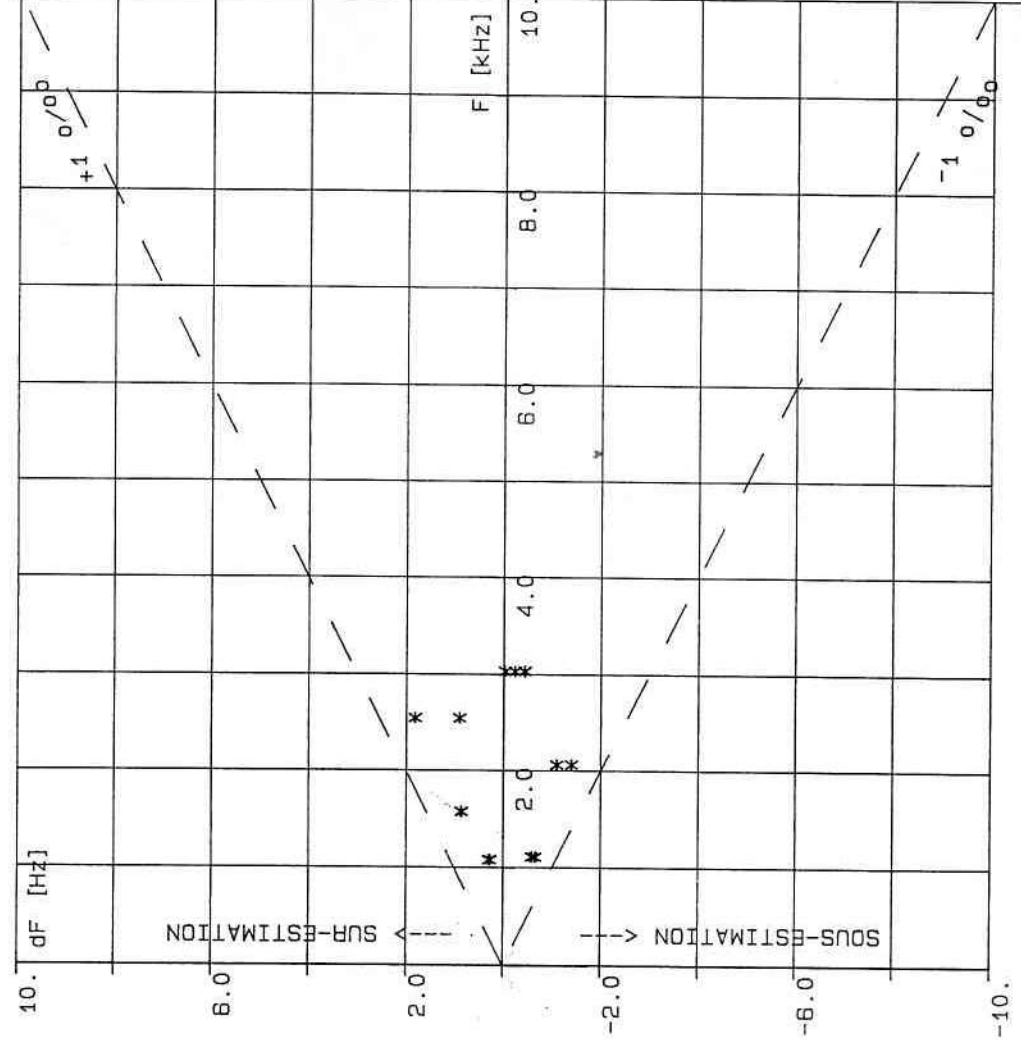
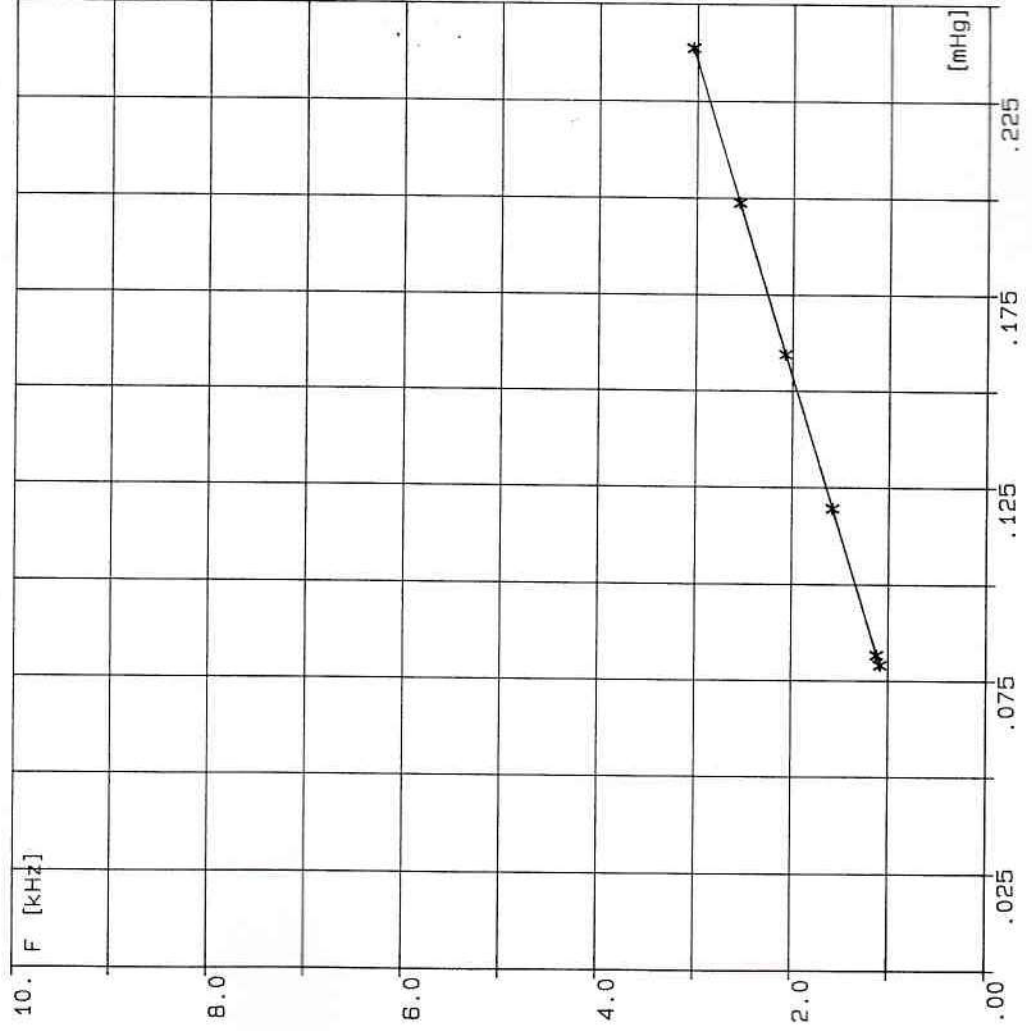
328-00-30 GABRIEL TERRA NEYRPIC

EPFL/IMHEF

ETALONNAGE de 1a chute (capteur HBM PD1 No 2944)

06 AVR 92

Pente = .08162 [mHg/kHz] Ord. = .11040 [kHz]





***328-01*** .

***RENDIMIENTO***

# GABRIEL TERRA

## Essai de rendement du 01/04 au 03/04/92

Par rapport au CR du 01/04/92 résumant le programme des essais adopté le 01/04/92, les modifications suivantes peuvent être notées:

- 1) le  $\alpha_p = 34^\circ$  a été essayé à la place du  $\alpha_p = 36^\circ$ .
- 2) des essais à  $n_{11} = C^{te}$  (121.2 - 132.2 - 147 tr/min) ont été effectués en plus.

Le calcul du rendement prototype d'après la formule de Hutton (annexes AR1 - AR2 du 03/04/92) permet le tracé des courbes  $\eta_p$ ,  $Q_p$  (en fonction de la puissance prototype (graph. R1 - R2 - R3)).

Le calcul du rendement pondéré donne: (cf annexe AR3)

$\eta$  moyen pondéré déduit des essais = 93,53%  
pour  $\eta$  moyen pondéré garanti = 92,65%.

La garantie de rendement est donc satisfaite.

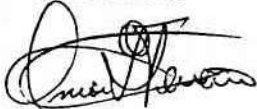
Lausanne, le 03/04/92

pour U.T.E.:

Mme Tomalino



M. Ferreno



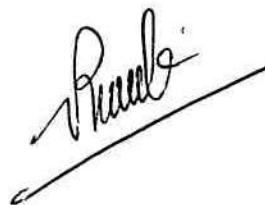
pour EDF:

M. Robert



pour NP:

M. Vinh



pour IMHEF:

M. Mombelli



| 328-01<br>No 15 |                   | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |                                  |              |            | Contrôle des prises de pression |                     |               |                |              | Fecha: 01 Avr 92<br>Date: |   |               |                 |             |               |
|-----------------|-------------------|---|----------------------------------|--------------|------------|---------------------------------|---------------------|---------------|----------------|--------------|---------------------------|---|---------------|-----------------|-------------|---------------|
| No              | $\alpha_p$<br>(°) | $\gamma_d$<br>(mm)                            | $\dot{V}$<br>(m <sup>3</sup> /s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min)                   | Te<br>(°C)          | $\eta$<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW)               | $\varphi$<br>(-)  | $\psi$<br>(-) | $\sigma$<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 239.            | 27.0              | 27.4  | .4011                            | 58.728       | 268.29     | 765.7                           | 15.82               | 91.42         | 118.9          | 1135.1       | 10.165                    | .2321   | .5060         | 1.7369          | -.970       | 366.4         |
| 240.            | 27.0              | 27.4  | .4015                            | 58.761       | 268.29     | 765.7                           | 15.83               | 91.28         | 118.9          | 1135.8       | 10.157                    | .2324   | .5063         | 1.7356          | -.968       | 366.3         |
| 241.            | 27.0              | 27.4  | .4015                            | 58.733       | 268.05     | 765.8                           | 15.83               | 91.26         | 118.9          | 1136.0       | 10.156                    | .2323   | .5060         | 1.7382          | -.968       | 366.3         |
| 242.            | 27.0              | 27.4  | .4016                            | 58.754       | 268.34     | 765.8                           | 15.83               | 91.29         | 118.9          | 1136.3       | 10.162                    | .2324   | .5061         | 1.7377          | -.969       | 366.3         |
| 243.            | 27.0              | 27.4  | .4020                            | 58.773       | 268.22     | 765.5                           | 15.83               | 91.11         | 118.8          | 1137.1       | 10.149                    | .2327   | .5066         | 1.7371          | -.968       | 366.4         |
| 244.            | 27.0              | 27.4  | .4015                            | 58.758       | 268.54     | 765.3                           | 15.84               | 91.32         | 118.8          | 1135.9       | 10.162                    | .2325   | .5068         | 1.7376          | -.969       | 366.4         |
| 245.            | 27.0              | 27.4  | .4018                            | 58.833       | 268.34     | 765.3                           | 15.84               | 91.06         | 118.7          | 1136.1       | 10.135                    | .2327   | .5075         | 1.7344          | -.963       | 366.3         |
| 246.            | 27.0              | 27.4  | .4018                            | 58.836       | 268.44     | 765.3                           | 15.84               | 91.11         | 118.7          | 1135.9       | 10.138                    | .2326   | .5074         | 1.7341          | -.962       | 366.4         |
| 247.            | 27.0              | 27.4  | .4015                            | 58.798       | 268.44     | 765.4                           | 15.84               | 91.24         | 118.8          | 1135.4       | 10.149                    | .2324   | .5071         | 1.7359          | -.966       | 366.4         |
| 248.            | 27.0              | 27.4  | .4016                            | 58.740       | 268.44     | 765.4                           | 15.85               | 91.29         | 118.8          | 1136.5       | 10.164                    | .2325   | .5065         | 1.7384          | -.970       | 366.3         |
| 249.            | 27.0              | 27.4  | .4015                            | 58.743       | 268.37     | 765.4                           | 15.85               | 91.29         | 118.8          | 1136.2       | 10.160                    | .2325   | .5066         | 1.7382          | -.970       | 366.4         |
| 250.            | 27.0              | 27.4  | .4010                            | 58.758       | 268.60     | 765.3                           | 15.85               | 91.46         | 118.8          | 1134.5       | 10.165                    | .2322   | .5068         | 1.7376          | -.969       | 366.3         |
| 251.            | 27.0              | 27.4  | .4013                            | 58.772       | 268.37     | 765.5                           | 15.86               | 91.30         | 118.8          | 1135.2       | 10.154                    | .2323   | .5067         | 1.7370          | -.968       | 366.4         |
| GABRIEL TERRA   |                   | U.T.E.  |                                  |              |            |                                 | GEC ALSTHOM NEYRPIC |               |                |              |                           | IMHEF<br>INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE |               |                 |             |               |

pour env. Rebours

30/04/92

Rebours

Rebours

328-01 16

Ensayo : Rendement  
Essai :

Runner : 5-KN-35

Fecha : 01 AVR 92  
Date :

| No   | $\alpha_p$<br>(°) | $\gamma_d$<br>(mm) | $\dot{V}$<br>(m <sup>3</sup> /s) | gH<br>(J/Kg) | T <sub>i</sub><br>(Nm) | N <sub>m</sub><br>(t/min) | T <sub>e</sub><br>(°C) | $\eta$<br>(%) | n <sub>11</sub><br>(t/min) | Q <sub>11</sub><br>(l/s) | P <sub>11</sub><br>(kW) | $\varphi$<br>(-) | $\psi$<br>(-) | $\sigma$<br>(-) | H <sub>s</sub><br>(mCE) | N <sub>p</sub><br>(t/min) |
|------|-------------------|--------------------|----------------------------------|--------------|------------------------|---------------------------|------------------------|---------------|----------------------------|--------------------------|-------------------------|------------------|---------------|-----------------|-------------------------|---------------------------|
| 252. | 27.0              | 27.4               | .3953                            | 59.047       | 276.05                 | 730.7                     | 15.93                  | 90.58         | 113.2                      | 1115.7                   | 9.900                   | .2398            | .5587         | 1.7282          | -.964                   | 363.4                     |
| 253. | 27.0              | 27.4               | .3973                            | 58.870       | 271.52                 | 745.6                     | 15.93                  | 90.74         | 115.6                      | 1122.8                   | 9.981                   | .2361            | .5350         | 1.7336          | -.966                   | 364.4                     |
| 254. | 27.0              | 27.4               | .4008                            | 58.964       | 270.26                 | 760.7                     | 15.93                  | 91.19         | 117.9                      | 1132.0                   | 10.112                  | .2335            | .5148         | 1.7313          | -.969                   | 366.4                     |
| 255. | 27.0              | 27.4               | .4035                            | 58.735       | 266.09                 | 775.5                     | 15.94                  | 91.29         | 120.4                      | 1141.6                   | 10.210                  | .2305            | .4933         | 1.7383          | -.970                   | 367.4                     |
| 256. | 27.0              | 27.4               | .4047                            | 58.779       | 269.54                 | 790.5                     | 15.94                  | 90.40         | 122.7                      | 1144.9                   | 10.139                  | .2269            | .4752         | 1.7376          | -.974                   | 368.4                     |
| 257. | 27.0              | 27.4               | .4023                            | 59.010       | 269.51                 | 768.6                     | 15.96                  | 91.46         | 119.1                      | 1135.8                   | 10.176                  | .2320            | .5047         | 1.7300          | -.969                   | 367.4                     |
| 258. | 27.0              | 27.4               | .4047                            | 58.895       | 266.13                 | 780.7                     | 15.96                  | 91.37         | 121.0                      | 1143.7                   | 10.237                  | .2298            | .4882         | 1.7339          | -.972                   | 368.3                     |
| 259. | 27.0              | 27.4               | .4052                            | 58.794       | 264.45                 | 784.4                     | 15.97                  | 91.27         | 121.7                      | 1146.1                   | 10.247                  | .2289            | .4827         | 1.7366          | -.971                   | 368.3                     |
| 260. | 27.0              | 27.4               | .4029                            | 58.711       | 265.95                 | 775.7                     | 15.97                  | 91.42         | 120.5                      | 1140.3                   | 10.212                  | .2302            | .4930         | 1.7388          | -.969                   | 367.4                     |
| 261. | 27.0              | 24.9               | .3614                            | 58.815       | 275.87                 | 660.7                     | 15.98                  | 89.89         | 102.5                      | 1022.0                   | 8.999                   | .2424            | .6807         | 1.7358          | -.970                   | 346.4                     |
| 262. | 27.0              | 24.9               | .3634                            | 58.773       | 272.02                 | 675.7                     | 15.98                  | 90.21         | 104.9                      | 1028.0                   | 9.085                   | .2383            | .6503         | 1.7372          | -.971                   | 347.4                     |
| 263. | 27.0              | 24.9               | .3662                            | 59.046       | 270.64                 | 690.6                     | 15.99                  | 90.60         | 106.9                      | 1033.5                   | 9.173                   | .2350            | .6256         | 1.7295          | -.973                   | 349.4                     |
| 264. | 27.0              | 24.9               | .3673                            | 58.693       | 266.62                 | 700.5                     | 15.99                  | 90.81         | 108.8                      | 1039.7                   | 9.250                   | .2324            | .6043         | 1.7400          | -.973                   | 349.4                     |
| 265. | 27.0              | 24.9               | .3690                            | 58.941       | 267.16                 | 705.5                     | 15.99                  | 90.86         | 109.4                      | 1042.2                   | 9.277                   | .2318            | .5982         | 1.7344          | -.974                   | 350.4                     |
| 266. | 27.0              | 24.9               | .3696                            | 58.803       | 264.56                 | 710.5                     | 15.99                  | 90.67         | 110.3                      | 1045.3                   | 9.284                   | .2305            | .5884         | 1.7372          | -.976                   | 350.4                     |
| 267. | 27.0              | 24.9               | .3696                            | 58.685       | 262.11                 | 715.5                     | 15.99                  | 90.63         | 111.1                      | 1046.4                   | 9.290                   | .2289            | .5791         | 1.7407          | -.976                   | 350.4                     |
| 268. | 27.0              | 24.9               | .3698                            | 58.693       | 258.73                 | 720.5                     | 16.00                  | 90.04         | 111.9                      | 1046.7                   | 9.232                   | .2274            | .5713         | 1.7403          | -.975                   | 350.4                     |
| 268. | 27.0              | 30.0               | .4258                            | 58.864       | 277.47                 | 780.8                     | 16.00                  | 90.62         | 121.1                      | 1203.4                   | 10.683                  | .2416            | .4878         | 1.7332          | -.963                   | 379.3                     |
| 269. | 27.0              | 30.0               | .4296                            | 58.823       | 272.60                 | 800.7                     | 16.01                  | 90.56         | 124.2                      | 1214.6                   | 10.775                  | .2377            | .4635         | 1.7343          | -.962                   | 381.4                     |
| 270. | 27.0              | 30.0               | .4348                            | 59.050       | 270.72                 | 820.6                     | 16.01                  | 90.71         | 127.1                      | 1227.0                   | 10.903                  | .2348            | .4430         | 1.7298          | -.966                   | 384.3                     |
| 271. | 27.0              | 30.0               | .4378                            | 59.075       | 268.59                 | 835.5                     | 16.01                  | 90.95         | 129.3                      | 1235.3                   | 11.006                  | .2322            | .4276         | 1.7257          | -.965                   | 386.4                     |
| 272. | 27.0              | 30.0               | .4386                            | 58.769       | 266.42                 | 840.5                     | 16.02                  | 91.07         | 130.5                      | 1240.7                   | 11.069                  | .2313            | .4203         | 1.7366          | -.967                   | 386.3                     |
| 273. | 27.0              | 30.0               | .4405                            | 58.923       | 266.56                 | 845.5                     | 16.02                  | 91.03         | 131.1                      | 1244.4                   | 11.097                  | .2309            | .4164         | 1.7321          | -.967                   | 387.3                     |
| 274. | 27.0              | 30.0               | .4419                            | 59.084       | 266.55                 | 850.4                     | 16.02                  | 91.01         | 131.7                      | 1246.8                   | 11.115                  | .2303            | .4128         | 1.7272          | -.966                   | 388.3                     |
| 275. | 27.0              | 30.0               | .4440                            | 58.975       | 263.89                 | 860.4                     | 16.03                  | 90.89         | 133.3                      | 1253.9                   | 11.164                  | .2287            | .4052         | 1.7324          | -.968                   | 389.4                     |
| 276. | 27.0              | 30.0               | .4445                            | 58.818       | 256.52                 | 870.3                     | 16.04                  | 89.52         | 135.0                      | 1256.9                   | 11.022                  | .2263            | .3923         | 1.7355          | -.969                   | 389.3                     |
| 277. | 27.0              | 32.5               | .4663                            | 59.034       | 271.53                 | 870.3                     | 16.05                  | 90.00         | 134.8                      | 1316.0                   | 11.602                  | .2374            | .3938         | 1.7276          | -.960                   | 401.4                     |
| 278. | 27.0              | 32.5               | .4715                            | 59.050       | 268.57                 | 890.5                     | 16.06                  | 90.05         | 137.9                      | 1330.5                   | 11.737                  | .2346            | .3782         | 1.7272          | -.961                   | 404.4                     |
| 279. | 27.0              | 32.5               | .4763                            | 58.752       | 264.19                 | 910.8                     | 16.07                  | 90.14         | 141.4                      | 1347.6                   | 11.899                  | .2318            | .3578         | 1.7364          | -.963                   | 406.8                     |
| 280. | 27.0              | 32.5               | .4791                            | 58.824       | 263.06                 | 920.7                     | 16.07                  | 90.09         | 142.8                      | 1354.8                   | 11.956                  | .2306            | .3506         | 1.7346          | -.965                   | 408.3                     |
| 281. | 27.0              | 32.5               | .4804                            | 58.912       | 263.22                 | 925.7                     | 16.08                  | 90.25         | 143.5                      | 1357.4                   | 12.001                  | .2300            | .3473         | 1.7322          | -.966                   | 409.4                     |
| 282. | 27.0              | 32.5               | .4825                            | 58.745       | 260.58                 | 935.6                     | 16.08                  | 90.18         | 145.3                      | 1365.1                   | 12.059                  | .2285            | .3390         | 1.7371          | -.966                   | 410.4                     |
| 283. | 27.0              | 32.5               | .4846                            | 58.814       | 258.23                 | 945.6                     | 16.09                  | 89.81         | 146.7                      | 1370.4                   | 12.056                  | .2271            | .3323         | 1.7350          | -.966                   | 411.8                     |
| 284. | 27.0              | 32.5               | .4856                            | 58.936       | 251.63                 | 955.6                     | 16.10                  | 88.08         | 148.1                      | 1371.8                   | 11.835                  | .2252            | .3261         | 1.7310          | -.964                   | 412.4                     |
| 284. | 27.0              | 32.5               | .4856                            | 58.936       | 251.63                 | 955.6                     | 16.10                  | 88.08         | 148.1                      | 1371.8                   | 11.835                  | .2252            | .3261         | 1.7310          | -.964                   | 412.4                     |
| 285. | 27.0              | 35.0               | .5134                            | 58.815       | 262.90                 | 975.4                     | 16.14                  | 89.03         | 151.4                      | 1451.8                   | 12.661                  | .2332            | .3123         | 1.7336          | -.968                   | 428.4                     |
| 286. | 27.0              | 35.0               | .5200                            | 58.903       | 260.93                 | 995.4                     | 16.14                  | 88.89         | 154.3                      | 1469.3                   | 12.795                  | .2315            | .3003         | 1.7312          | -.950                   | 432.0                     |
| 287. | 27.0              | 35.0               | .5223                            | 58.770       | 258.53                 | 1005.4                    | 16.16                  | 88.77         | 156.1                      | 1477.5                   | 12.848                  | .2302            | .2937         | 1.7353          | -.961                   | 433.4                     |
| 288. | 27.0              | 35.0               | .5259                            | 58.868       | 257.23                 | 1015.8                    | 16.16                  | 88.47         | 157.5                      | 1486.5                   | 12.883                  | .2295            | .2883         | 1.7341          | -.961                   | 435.4                     |

GABRIEL TERRA U.T.E. GEC ALSTHOM NEYRPIC



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MECANIQUE DES FLUIDES  
ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE

pour info: Phobert  
H. M. C. H.



| 328-01<br>Nº 18 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 01 AVR 92<br>Date: |          |          |             |               |
|-----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|
| No              | αp<br>(°) | γd<br>(mm)                                    | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 289.            | 27.0      | 35.0  | .5287       | 59.012       | 256.29     | 1025.9        | 16.17      | 88.35    | 158.9          | 1492.5       | 12.916      | .2284                     | .2833    | 1.7284   | -.962       | 437.4         |
| 290.            | 27.0      | 35.0  | .5308       | 58.835       | 251.31     | 1035.7        | 16.19      | 87.37    | 160.7          | 1500.8       | 12.844      | .2271                     | .2771    | 1.7336   | -.962       | 438.4         |
| 291.            | 27.0      | 35.0  | .5147       | 58.654       | 273.27     | 940.7         | 16.22      | 89.26    | 146.2          | 1457.4       | 12.744      | .2425                     | .3349    | 1.7396   | -.957       | 428.4         |
| 292.            | 27.0      | 35.0  | .5152       | 58.803       | 263.02     | 975.6         | 16.26      | 88.79    | 151.4          | 1457.0       | 12.673      | .2340                     | .3121    | 1.7334   | -.956       | 428.4         |
| 293.            | 27.0      | 35.0  | .5060       | 59.143       | 270.03     | 940.6         | 16.29      | 88.98    | 145.5          | 1426.7       | 12.435      | .2384                     | .3378    | 1.7233   | -.956       | 423.4         |
| 294.            | 27.0      | 35.0  | .4991       | 58.842       | 270.89     | 920.4         | 16.31      | 89.01    | 142.8          | 1410.9       | 12.301      | .2403                     | .3509    | 1.7338   | -.956       | 419.5         |
| 295.            | 24.1      | 25.3  | .3457       | 58.477       | 245.73     | 710.5         | 16.29      | 90.54    | 110.6          | 980.4        | 8.696       | .2156                     | .5851    | 1.7465   | -.977       | 338.3         |
| 296.            | 24.1      | 25.3  | .3494       | 58.701       | 243.09     | 730.4         | 16.29      | 90.77    | 113.4          | 988.9        | 8.793       | .2120                     | .5558    | 1.7396   | -.976       | 340.3         |
| 297.            | 24.1      | 25.3  | .3526       | 58.951       | 239.85     | 750.3         | 16.29      | 90.77    | 116.3          | 995.8        | 8.855       | .2082                     | .5290    | 1.7324   | -.977       | 342.4         |
| 298.            | 24.1      | 25.3  | .3536       | 58.625       | 236.43     | 760.3         | 16.29      | 90.90    | 118.2          | 1001.6       | 8.918       | .2061                     | .5124    | 1.7420   | -.976       | 342.4         |
| 299.            | 24.1      | 25.3  | .3558       | 58.668       | 234.90     | 770.3         | 16.29      | 90.88    | 119.7          | 1007.4       | 8.968       | .2047                     | .4995    | 1.7410   | -.978       | 343.4         |
| 300.            | 24.1      | 25.3  | .3579       | 58.582       | 227.91     | 790.7         | 16.29      | 90.10    | 122.9          | 1014.1       | 8.951       | .2006                     | .4734    | 1.7430   | -.975       | 344.4         |
| 301.            | 24.1      | 25.3  | .3610       | 58.889       | 223.69     | 810.6         | 16.30      | 89.42    | 125.7          | 1020.2       | 8.936       | .1974                     | .4527    | 1.7339   | -.975       | 346.3         |
| 302.            | 24.1      | 22.5  | .3176       | 58.947       | 242.78     | 660.2         | 16.30      | 89.75    | 102.3          | 897.2        | 7.887       | .2132                     | .6831    | 1.7327   | -.978       | 326.3         |
| 303.            | 24.1      | 22.5  | .3199       | 58.909       | 238.17     | 680.2         | 16.30      | 90.12    | 105.5          | 903.9        | 7.980       | .2084                     | .6431    | 1.7337   | -.977       | 327.3         |
| 304.            | 24.1      | 22.5  | .3224       | 58.753       | 233.47     | 700.6         | 16.29      | 90.51    | 108.8          | 912.3        | 8.088       | .2040                     | .6048    | 1.7388   | -.980       | 328.3         |
| 305.            | 24.1      | 22.5  | .3242       | 58.915       | 226.04     | 720.7         | 16.29      | 89.39    | 111.7          | 916.1        | 8.022       | .1994                     | .5731    | 1.7341   | -.981       | 329.3         |
| 306.            | 24.1      | 22.5  | .3262       | 58.938       | 219.36     | 740.5         | 16.30      | 88.56    | 114.8          | 921.6        | 7.995       | .1952                     | .5430    | 1.7334   | -.980       | 330.3         |
| 307.            | 24.1      | 22.5  | .3210       | 58.492       | 233.64     | 695.2         | 16.29      | 90.69    | 108.2          | 910.2        | 8.086       | .2046                     | .6113    | 1.7465   | -.980       | 327.3         |
| 308.            | 24.1      | 27.5  | .3717       | 59.088       | 249.00     | 760.5         | 16.30      | 90.40    | 117.7          | 1048.5       | 9.285       | .2166                     | .5161    | 1.7272   | -.970       | 351.4         |
| 309.            | 24.1      | 27.5  | .3748       | 58.761       | 243.74     | 780.4         | 16.30      | 90.54    | 121.1          | 1060.3       | 9.404       | .2128                     | .4875    | 1.7369   | -.970       | 352.4         |
| 310.            | 24.1      | 27.5  | .3781       | 58.806       | 239.95     | 800.7         | 16.30      | 90.57    | 124.2          | 1069.4       | 9.488       | .2093                     | .4634    | 1.7361   | -.973       | 354.4         |
| 311.            | 24.1      | 27.5  | .3821       | 58.864       | 236.34     | 820.8         | 16.31      | 90.41    | 127.3          | 1080.1       | 9.566       | .2063                     | .4414    | 1.7345   | -.974       | 356.4         |
| 312.            | 24.1      | 27.5  | .3828       | 58.667       | 234.36     | 825.7         | 16.31      | 90.33    | 128.3          | 1084.0       | 9.591       | .2055                     | .4347    | 1.7403   | -.974       | 356.4         |
| 313.            | 24.1      | 27.5  | .3834       | 58.932       | 234.57     | 830.6         | 16.31      | 90.41    | 128.8          | 1083.0       | 9.591       | .2045                     | .4316    | 1.7319   | -.971       | 357.4         |
| 314.            | 24.1      | 27.5  | .3814       | 58.940       | 237.32     | 818.5         | 16.32      | 90.58    | 126.9          | 1077.4       | 9.560       | .2065                     | .4445    | 1.7323   | -.974       | 356.4         |
| 315.            | 24.1      | 27.5  | .3802       | 58.790       | 237.61     | 812.3         | 16.32      | 90.52    | 126.1          | 1075.4       | 9.536       | .2074                     | .4501    | 1.7367   | -.974       | 355.3         |
| 316.            | 24.1      | 27.5  | .3859       | 58.897       | 232.96     | 840.4         | 16.32      | 90.30    | 130.3          | 1090.5       | 9.646       | .2035                     | .4213    | 1.7334   | -.973       | 358.4         |
| 317.            | 24.1      | 27.5  | .3875       | 58.977       | 230.48     | 850.7         | 16.33      | 89.96    | 131.8          | 1094.1       | 9.641       | .2018                     | .4117    | 1.7308   | -.972       | 359.3         |
| 318.            | 24.1      | 30.0  | .4002       | 58.877       | 246.36     | 820.3         | 16.33      | 89.92    | 127.2          | 1131.0       | 9.962       | .2162                     | .4420    | 1.7322   | -.963       | 365.4         |
| 319.            | 24.1      | 30.0  | .4039       | 58.777       | 242.50     | 840.8         | 16.33      | 90.03    | 130.5          | 1142.6       | 10.077      | .2129                     | .4200    | 1.7354   | -.964       | 367.4         |
| 320.            | 24.1      | 30.0  | .4089       | 59.093       | 241.01     | 860.7         | 16.34      | 90.00    | 133.2          | 1153.5       | 10.170      | .2105                     | .4030    | 1.7267   | -.968       | 370.4         |
| 321.            | 24.1      | 30.0  | .4135       | 59.035       | 237.42     | 880.7         | 16.34      | 89.81    | 136.4          | 1167.0       | 10.266      | .2080                     | .3845    | 1.7286   | -.969       | 372.4         |
| 322.            | 24.1      | 30.0  | .4172       | 58.909       | 233.35     | 900.7         | 16.35      | 89.65    | 139.6          | 1178.8       | 10.352      | .2053                     | .3669    | 1.7318   | -.966       | 374.4         |
| 323.            | 24.1      | 30.0  | .4211       | 58.724       | 229.92     | 920.4         | 16.35      | 89.72    | 142.9          | 1191.6       | 10.472      | .2027                     | .3502    | 1.7377   | -.969       | 376.3         |
| 324.            | 24.1      | 30.0  | .4248       | 58.778       | 223.86     | 940.5         | 16.36      | 88.39    | 146.0          | 1201.6       | 10.404      | .2002                     | .3357    | 1.7358   | -.967       | 378.3         |
| 325.            | 24.1      | 33.3  | .4448       | 58.951       | 242.43     | 920.7         | 16.42      | 89.22    | 142.7          | 1256.4       | 10.981      | .2141                     | .3514    | 1.7295   | -.960       | 389.3         |

GABRIEL TERRA U.T.E. GEC ALSTHOM NEYRPIC



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE


*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

pour C de

| 328-01<br>Nº 20 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |              |              |            |               |            |          |                |              |             | Fecha : 01 AVR 92<br>Date: |          |          |             |               |  |  |  |  |
|-----------------|-----------|---|--------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|----------------------------|----------|----------|-------------|---------------|--|--|--|--|
| No              | αp<br>(°) | γd<br>(mm)                                    | V̇<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                   | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |  |  |  |  |
| 326.            | 24.1      | 33.3  | .4488        | 58.513       | 238.24     | 940.6         | 16.43      | 89.30    | 146.2          | 1271.4       | 11.121      | .2115                      | .3347    | 1.7403   | -.965       | 391.4         |  |  |  |  |
| 327.            | 24.1      | 33.3  | .4547        | 58.762       | 236.29     | 960.5         | 16.43      | 89.05    | 149.1          | 1286.4       | 11.221      | .2098                      | .3218    | 1.7360   | -.966       | 394.3         |  |  |  |  |
| 328.            | 24.1      | 33.3  | .4578        | 59.035       | 235.98     | 970.7         | 16.44      | 88.86    | 150.3          | 1292.0       | 11.247      | .2090                      | .3165    | 1.7278   | -.965       | 396.3         |  |  |  |  |
| 329.            | 24.1      | 33.3  | .4595        | 58.904       | 233.70     | 980.6         | 16.44      | 88.76    | 152.0          | 1298.4       | 11.289      | .2077                      | .3095    | 1.7317   | -.966       | 397.3         |  |  |  |  |
| 330.            | 24.1      | 33.3  | .4617        | 58.790       | 231.16     | 990.5         | 16.45      | 88.43    | 153.7          | 1305.8       | 11.312      | .2066                      | .3027    | 1.7348   | -.964       | 398.3         |  |  |  |  |
| 331.            | 24.1      | 33.3  | .4647        | 59.016       | 230.93     | 1000.8        | 16.46      | 88.35    | 155.0          | 1311.8       | 11.353      | .2058                      | .2976    | 1.7282   | -.965       | 400.3         |  |  |  |  |
| 332.            | 24.1      | 33.3  | .4671        | 58.980       | 228.27     | 1010.4        | 16.46      | 87.76    | 156.6          | 1319.1       | 11.340      | .2049                      | .2919    | 1.7288   | -.962       | 401.4         |  |  |  |  |
| 333.            | 24.1      | 33.3  | .4687        | 58.793       | 225.16     | 1020.5        | 16.47      | 87.41    | 158.4          | 1325.7       | 11.351      | .2035                      | .2852    | 1.7343   | -.962       | 402.4         |  |  |  |  |
| 334.            | 24.1      | 33.3  | .4522        | 58.864       | 238.56     | 948.4         | 16.50      | 89.12    | 147.1          | 1278.1       | 11.157      | .2113                      | .3306    | 1.7325   | -.964       | 392.9         |  |  |  |  |
| 335.            | 24.1      | 30.0  | .4272        | 58.921       | 222.81     | 948.8         | 16.51      | 88.06    | 147.1          | 1206.9       | 10.410      | .1995                      | .3306    | 1.7316   | -.969       | 379.8         |  |  |  |  |
| 336.            | 24.1      | 30.7  | .4335        | 58.961       | 228.71     | 948.8         | 16.52      | 89.01    | 147.0          | 1224.3       | 10.675      | .2025                      | .3309    | 1.7302   | -.968       | 383.3         |  |  |  |  |
| 337.            | 24.1      | 31.2  | .4363        | 58.993       | 231.02     | 948.6         | 16.53      | 89.25    | 147.0          | 1232.0       | 10.771      | .2039                      | .3312    | 1.7290   | -.966       | 385.0         |  |  |  |  |
| 338.            | 24.1      | 31.5  | .4394        | 58.893       | 231.58     | 948.7         | 16.54      | 89.01    | 147.1          | 1241.6       | 10.826      | .2052                      | .3306    | 1.7317   | -.965       | 386.3         |  |  |  |  |
| 339.            | 24.1      | 31.9  | .4426        | 58.764       | 232.94     | 948.4         | 16.55      | 89.05    | 147.2          | 1252.1       | 10.921      | .2068                      | .3301    | 1.7357   | -.966       | 387.7         |  |  |  |  |
| 340.            | 24.1      | 33.9  | .4559        | 59.004       | 240.40     | 948.8         | 16.55      | 88.89    | 147.0          | 1287.2       | 11.208      | .2129                      | .3311    | 1.7279   | -.962       | 395.4         |  |  |  |  |
| 341.            | 24.1      | 32.6  | .4472        | 58.920       | 236.09     | 947.5         | 16.57      | 89.02    | 146.9          | 1263.3       | 11.015      | .2091                      | .3315    | 1.7312   | -.967       | 390.3         |  |  |  |  |
| 342.            | 24.1      | 27.4  | .3873        | 58.915       | 229.97     | 852.5         | 16.58      | 90.08    | 132.2          | 1094.1       | 9.654       | .2013                      | .4096    | 1.7326   | -.975       | 359.3         |  |  |  |  |
| 343.            | 24.1      | 27.7  | .3905        | 59.026       | 232.75     | 852.5         | 16.58      | 90.25    | 132.0          | 1102.2       | 9.743       | .2030                      | .4103    | 1.7291   | -.973       | 360.9         |  |  |  |  |
| 344.            | 24.1      | 28.1  | .3938        | 58.985       | 234.71     | 852.5         | 16.58      | 90.30    | 132.1          | 1112.1       | 9.836       | .2047                      | .4101    | 1.7297   | -.970       | 362.3         |  |  |  |  |
| 345.            | 24.1      | 28.6  | .3969        | 58.807       | 235.68     | 852.5         | 16.58      | 90.25    | 132.3          | 1122.3       | 9.922       | .2063                      | .4088    | 1.7351   | -.970       | 363.8         |  |  |  |  |
| 346.            | 24.1      | 29.0  | .4005        | 58.985       | 238.61     | 852.5         | 16.58      | 90.26    | 132.1          | 1131.0       | 10.000      | .2082                      | .4100    | 1.7301   | -.972       | 365.9         |  |  |  |  |
| 347.            | 24.1      | 29.6  | .4047        | 58.731       | 239.98     | 852.4         | 16.58      | 90.23    | 132.4          | 1145.2       | 10.122      | .2104                      | .4083    | 1.7369   | -.968       | 367.7         |  |  |  |  |
| 348.            | 24.1      | 30.6  | .4124        | 58.817       | 243.85     | 852.4         | 16.59      | 89.83    | 132.3          | 1166.2       | 10.262      | .2144                      | .4090    | 1.7338   | -.964       | 371.6         |  |  |  |  |
| 349.            | 24.1      | 25.1  | .3560        | 58.608       | 230.82     | 780.5         | 16.59      | 90.52    | 121.3          | 1008.5       | 8.942       | .2022                      | .4861    | 1.7420   | -.977       | 343.4         |  |  |  |  |
| 350.            | 24.1      | 25.4  | .3597        | 58.780       | 234.88     | 780.4         | 16.59      | 90.88    | 121.1          | 1017.6       | 9.058       | .2043                      | .4876    | 1.7370   | -.977       | 345.3         |  |  |  |  |
| 351.            | 24.1      | 25.8  | .3628        | 58.610       | 236.26     | 780.4         | 16.59      | 90.90    | 121.3          | 1027.7       | 9.151       | .2060                      | .4862    | 1.7420   | -.977       | 346.6         |  |  |  |  |
| 352.            | 24.1      | 26.4  | .3686        | 58.689       | 240.02     | 780.3         | 16.59      | 90.76    | 121.2          | 1043.4       | 9.276       | .2093                      | .4870    | 1.7394   | -.975       | 349.3         |  |  |  |  |
| 353.            | 24.1      | 27.3  | .3748        | 58.653       | 243.75     | 780.3         | 16.59      | 90.72    | 121.2          | 1061.2       | 9.430       | .2128                      | .4866    | 1.7397   | -.971       | 352.3         |  |  |  |  |
| 354.            | 24.1      | 28.0  | .3812        | 58.814       | 247.64     | 780.3         | 16.59      | 90.36    | 121.1          | 1077.9       | 9.540       | .2165                      | .4880    | 1.7342   | -.967       | 355.6         |  |  |  |  |
| GABRIEL TERRA   |           | U.T.E.  |              |              |            |               |            |          |                |              |             | GEC ALSTHOM NEYRPEC        |          |          |             |               |  |  <b>IMHEF</b><br>INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE |  |  |

pour U.T.E. *B. Guillemin* pour E.D.F. *Robert* pour IMHEF *W. Haller*

**328-01-21**

**GABRIEL TERRA**

01 AVR 92

## Rendement

Roue : 5-KN-35

18:24:02

## PARAMETRES D'ESSAI

|                      |         | Pentes          | Ordonnees |
|----------------------|---------|-----------------|-----------|
| TEMPERATURE          | gamme 1 | 9.88410         | -.04160   |
| DEBIT 1<br>(turbine) | gamme 1 | .04405          | .30340    |
|                      | gamme 2 | .30119          | .02730    |
|                      | gamme 3 | .00000          | .00000    |
| DEBIT 1<br>(pompe)   | gamme 1 | .00000          | .00000    |
|                      | gamme 2 | .00000          | .00000    |
|                      | gamme 3 | .00000          | .00000    |
| ENERGIE<br>(PD1)     | gamme 1 | .08170          | .11930    |
|                      | gamme 2 | .00000          | .00000    |
| CAVITATION           | gamme 1 | .08250          | .10312    |
|                      | gamme 2 | .08239          | -.06490   |
|                      | gamme 3 | .00000          | .00000    |
| COUPLE 2             | gamme 1 | 24.80748        | .19442    |
|                      | gamme 2 | .00000          | .00000    |
| COUPLE FROT.         | Stand 2 | .91743          | .14606    |
| POUSSEE AX.          | gamme 1 | .00000          | .00000    |
| COEFFICIENT DE GAMME |         | 2 1 0 1 2 6 2 1 |           |

## CONSTANTES

|                        |         |          |            |          |
|------------------------|---------|----------|------------|----------|
| RAYON DE CEINTURE      | C-1e    | .19000   | R1i        | .00000   |
| SECTIONS               | Mont    | .23646   | Aval       | .60690   |
| ACC. TERRESTRE         | Univ.   | 9.80665  | Locale     | 9.80630  |
| DIAM. STATORS          | Stand 1 | 1.27985  | Stand 2    | 1.08020  |
| R CAPT. FROT.          | Stand 1 | .26585   | Stand 2    | .26465   |
| MASSE PLATEAUX         | Stand 1 | 20.18490 | Stand 2    | 20.18470 |
| MASSE ADDITION.        | [kg]    | .00000   | u PIEZO    | 998.50   |
| (uHg-uH2O)g            | Chute   | 123026.7 | Haut. asp. | 123044.4 |
| DIAM. REFERENCE        |         | .00000   | VIT. REF.  | .00000   |
| PRESSION ATM. CORRIGEE |         | 94700.0  |            |          |

FICHER : TERR04.DAT    Dernier enregistrement : 54

6 of 8      P. Robert      NO. ONE      *Handwritten signature*      pour NP      *Handwritten signature*      pour JHHEF      10/1/21



| 328-01<br>Nº 22 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |              |              |            |               |            | Fecha: 02 AVR 92<br>Date: |                |              |             |          |          |          |             |               |
|-----------------|-----------|---|--------------|--------------|------------|---------------|------------|---------------------------|----------------|--------------|-------------|----------|----------|----------|-------------|---------------|
| No              | αp<br>(°) | γd<br>(mm)                                    | V̇<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%)                  | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-) | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 355.            | 30.1      | 30.0  | .4527        | 58.712       | 321.73     | 710.3         | 16.66      | 90.14                     | 110.3          | 1281.3       | 11.313      | .2825    | .5879    | 1.7463   | -.960       | 393.3         |
| 356.            | 30.1      | 30.0  | .4579        | 58.917       | 318.70     | 730.8         | 16.66      | 90.51                     | 113.3          | 1293.8       | 11.469      | .2777    | .5573    | 1.7402   | -.961       | 396.3         |
| 357.            | 30.1      | 30.0  | .4627        | 59.087       | 315.62     | 750.5         | 16.67      | 90.84                     | 116.2          | 1305.4       | 11.615      | .2732    | .5299    | 1.7354   | -.962       | 399.3         |
| 358.            | 30.1      | 30.0  | .4651        | 58.979       | 312.41     | 760.6         | 16.67      | 90.81                     | 117.8          | 1313.5       | 11.683      | .2710    | .5151    | 1.7388   | -.962       | 400.3         |
| 359.            | 30.1      | 30.0  | .4670        | 58.848       | 309.34     | 770.5         | 16.67      | 90.92                     | 119.5          | 1320.3       | 11.758      | .2686    | .5008    | 1.7430   | -.965       | 401.4         |
| 360.            | 30.1      | 30.0  | .4690        | 58.713       | 306.58     | 780.4         | 16.68      | 91.10                     | 121.2          | 1327.3       | 11.843      | .2663    | .4870    | 1.7469   | -.964       | 402.3         |
| 361.            | 30.1      | 30.0  | .4710        | 58.618       | 303.55     | 790.4         | 16.68      | 91.11                     | 122.8          | 1334.0       | 11.905      | .2641    | .4741    | 1.7498   | -.965       | 403.4         |
| 362.            | 30.1      | 30.0  | .4734        | 58.469       | 300.07     | 800.3         | 16.68      | 90.95                     | 124.5          | 1342.7       | 11.962      | .2622    | .4612    | 1.7551   | -.970       | 404.3         |
| 363.            | 30.1      | 30.0  | .4746        | 58.489       | 295.73     | 810.3         | 16.69      | 90.51                     | 126.1          | 1345.8       | 11.931      | .2595    | .4500    | 1.7544   | -.969       | 405.3         |
| 364.            | 30.1      | 30.0  | .4764        | 58.575       | 291.39     | 820.3         | 16.69      | 89.80                     | 127.5          | 1350.0       | 11.874      | .2574    | .4398    | 1.7517   | -.969       | 406.3         |
| 365.            | 30.1      | 27.4  | .4206        | 58.845       | 316.49     | 670.5         | 16.71      | 89.89                     | 104.0          | 1189.1       | 10.469      | .2780    | .6613    | 1.7433   | -.966       | 376.3         |
| 366.            | 30.1      | 27.4  | .4231        | 58.766       | 313.69     | 680.7         | 16.71      | 90.04                     | 105.7          | 1196.8       | 10.555      | .2754    | .6407    | 1.7458   | -.967       | 377.3         |
| 367.            | 30.1      | 27.4  | .4248        | 58.752       | 310.75     | 690.6         | 16.71      | 90.16                     | 107.2          | 1201.8       | 10.613      | .2726    | .6223    | 1.7464   | -.968       | 378.3         |
| 368.            | 30.1      | 27.4  | .4265        | 58.728       | 308.10     | 700.6         | 16.71      | 90.35                     | 108.8          | 1206.9       | 10.681      | .2698    | .6045    | 1.7471   | -.968       | 379.3         |
| 369.            | 30.1      | 27.4  | .4170        | 58.873       | 321.32     | 650.3         | 16.72      | 89.22                     | 100.9          | 1178.7       | 10.301      | .2842    | .7033    | 1.7422   | -.965       | 374.3         |
| 370.            | 30.1      | 27.4  | .4348        | 58.377       | 282.86     | 760.6         | 16.72      | 88.85                     | 118.5          | 1234.2       | 10.741      | .2534    | .5099    | 1.7580   | -.971       | 383.3         |
| 371.            | 30.1      | 32.4  | .4899        | 58.626       | 315.96     | 780.7         | 16.74      | 90.06                     | 121.3          | 1387.5       | 12.239      | .2781    | .4859    | 1.7484   | -.958       | 414.0         |
| 372.            | 30.1      | 32.4  | .4959        | 58.844       | 313.45     | 800.7         | 16.74      | 90.18                     | 124.2          | 1401.9       | 12.383      | .2744    | .4636    | 1.7419   | -.958       | 417.4         |
| 373.            | 30.1      | 32.4  | .5010        | 58.820       | 309.26     | 820.7         | 16.74      | 90.31                     | 127.3          | 1416.5       | 12.530      | .2705    | .4412    | 1.7428   | -.959       | 420.3         |
| 374.            | 30.1      | 32.4  | .5060        | 58.760       | 305.63     | 840.5         | 16.75      | 90.59                     | 130.5          | 1431.5       | 12.702      | .2668    | .4202    | 1.7447   | -.960       | 423.4         |
| 375.            | 30.1      | 32.4  | .5092        | 58.956       | 304.74     | 850.5         | 16.76      | 90.52                     | 131.8          | 1438.2       | 12.751      | .2653    | .4118    | 1.7391   | -.962       | 425.4         |
| 376.            | 30.1      | 32.4  | .5115        | 58.684       | 301.71     | 860.4         | 16.76      | 90.67                     | 133.7          | 1448.1       | 12.860      | .2635    | .4005    | 1.7477   | -.965       | 426.4         |
| 377.            | 30.1      | 32.4  | .5147        | 58.808       | 300.67     | 870.4         | 16.77      | 90.64                     | 135.1          | 1455.5       | 12.923      | .2621    | .3922    | 1.7445   | -.968       | 428.4         |
| 378.            | 30.1      | 32.4  | .5148        | 58.814       | 299.78     | 870.4         | 16.78      | 90.35                     | 135.1          | 1455.7       | 12.883      | .2621    | .3922    | 1.7443   | -.968       | 428.3         |
| 379.            | 30.1      | 32.4  | .5165        | 58.741       | 295.82     | 880.6         | 16.79      | 89.96                     | 136.7          | 1461.4       | 12.876      | .2599    | .3827    | 1.7462   | -.966       | 429.4         |
| 380.            | 30.1      | 32.4  | .5147        | 58.632       | 297.52     | 873.4         | 16.80      | 90.27                     | 135.7          | 1457.8       | 12.890      | .2612    | .3883    | 1.7497   | -.968       | 428.3         |
| 381.            | 30.1      | 32.4  | .5134        | 58.792       | 299.89     | 870.5         | 16.81      | 90.67                     | 135.1          | 1452.2       | 12.896      | .2614    | .3920    | 1.7448   | -.967       | 428.4         |
| 382.            | 30.1      | 35.0  | .5368        | 58.750       | 309.98     | 870.4         | 16.82      | 89.69                     | 135.1          | 1518.9       | 13.343      | .2733    | .3918    | 1.7438   | -.954       | 441.4         |
| 383.            | 30.1      | 35.0  | .5435        | 58.889       | 307.65     | 890.6         | 16.83      | 89.74                     | 138.1          | 1536.1       | 13.502      | .2705    | .3751    | 1.7402   | -.957       | 445.5         |
| 384.            | 30.1      | 35.0  | .5482        | 58.690       | 302.36     | 910.4         | 16.84      | 89.70                     | 141.4          | 1551.7       | 13.634      | .2668    | .3578    | 1.7465   | -.960       | 448.4         |
| 385.            | 30.1      | 35.0  | .5555        | 58.837       | 300.07     | 930.7         | 16.85      | 89.59                     | 144.4          | 1570.5       | 13.782      | .2645    | .3431    | 1.7422   | -.960       | 452.4         |
| 386.            | 30.1      | 35.0  | .5620        | 58.934       | 297.38     | 950.7         | 16.86      | 89.49                     | 147.4          | 1587.6       | 13.916      | .2620    | .3294    | 1.7399   | -.963       | 456.4         |
| 387.            | 30.1      | 35.0  | .5678        | 59.079       | 292.40     | 970.6         | 16.87      | 88.70                     | 150.3          | 1601.9       | 13.918      | .2592    | .3168    | 1.7355   | -.963       | 459.9         |
| 388.            | 30.1      | 35.0  | .5717        | 59.042       | 282.89     | 990.5         | 16.88      | 87.03                     | 153.4          | 1613.6       | 13.755      | .2558    | .3040    | 1.7366   | -.963       | 462.4         |
| 389.            | 30.1      | 35.0  | .5653        | 59.040       | 295.72     | 960.7         | 16.89      | 89.24                     | 148.8          | 1595.4       | 13.946      | .2608    | .3232    | 1.7370   | -.965       | 458.4         |
| 390.            | 30.1      | 37.5  | .5867        | 59.135       | 304.95     | 960.7         | 16.91      | 88.53                     | 148.7          | 1654.4       | 14.346      | .2706    | .3237    | 1.7324   | -.955       | 471.4         |
| 391.            | 30.1      | 37.5  | .5924        | 58.802       | 298.82     | 980.5         | 16.93      | 88.18                     | 152.2          | 1675.5       | 14.471      | .2678    | .3090    | 1.7421   | -.954       | 474.4         |
| 392.            | 30.1      | 37.5  | .5987        | 58.631       | 295.20     | 1000.5        | 16.94      | 88.21                     | 155.5          | 1695.7       | 14.650      | .2652    | .2959    | 1.7478   | -.958       | 478.4         |
| 393.            | 30.1      | 37.5  | .6061        | 59.082       | 294.23     | 1020.5        | 16.96      | 87.91                     | 158.0          | 1710.0       | 14.724      | .2632    | .2866    | 1.7344   | -.958       | 483.4         |
| 394.            | 30.1      | 37.5  | .6123        | 59.031       | 288.65     | 1040.8        | 16.97      | 87.15                     | 161.2          | 1728.2       | 14.751      | .2607    | .2753    | 1.7360   | -.958       | 487.4         |

GABRIEL TERRA

U.T.E.

GEC ALSTHOM NEYRPEC


 INSTITUT DE MACHINES HYDRAULIQUES  
 ET DE MÉCANIQUE DES FLUIDES  
 ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

 pour E et  
 P. R.

G. R.


P. R.

H. R.



| 328-01<br>Nº 24 |           | Ensayo : Rendement<br>Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 02 AVR 92<br>Date: |          |          |             |               |  |
|-----------------|-----------|--|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|--|
| No              | αp<br>(°) | γd<br>(mm)                             | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |  |
| 395.            | 30.1      | 37.5                                   | .6173       | 58.928       | 279.44     | 1060.7        | 17.00      | 85.43    | 164.4          | 1744.0       | 14.592      | .2579                     | .2646    | 1.7391   | -.959       | 490.4         |  |
| 396.            | 30.1      | 37.5                                   | .5918       | 58.585       | 296.09     | 980.7         | 17.01      | 88.41    | 152.5          | 1676.6       | 14.518      | .2674                     | .3077    | 1.7484   | -.954       | 474.4         |  |
| 397.            | 30.1      | 37.5                                   | .5839       | 59.241       | 307.43     | 950.7         | 17.04      | 88.60    | 147.0          | 1645.1       | 14.276      | .2722                     | .3311    | 1.7306   | -.954       | 469.9         |  |
| 398.            | 30.1      | 34.4                                   | .5565       | 59.034       | 293.58     | 950.4         | 17.07      | 89.04    | 147.2          | 1570.8       | 13.699      | .2595                     | .3302    | 1.7382   | -.963       | 453.0         |  |
| 399.            | 30.1      | 34.8                                   | .5612       | 59.337       | 299.50     | 950.6         | 17.08      | 89.64    | 146.8          | 1579.9       | 13.871      | .2616                     | .3318    | 1.7295   | -.964       | 456.4         |  |
| 400.            | 30.1      | 35.4                                   | .5657       | 59.150       | 300.18     | 950.5         | 17.10      | 89.41    | 147.1          | 1595.0       | 13.968      | .2637                     | .3308    | 1.7345   | -.962       | 458.8         |  |
| 401.            | 30.1      | 36.3                                   | .5736       | 59.061       | 302.89     | 950.6         | 17.13      | 89.11    | 147.2          | 1618.7       | 14.127      | .2674                     | .3302    | 1.7363   | -.957       | 463.8         |  |
| 402.            | 30.1      | 31.0                                   | .4956       | 58.963       | 293.33     | 852.4         | 17.17      | 89.72    | 132.1          | 1399.5       | 12.298      | .2576                     | .4100    | 1.7406   | -.966       | 417.4         |  |
| 403.            | 30.1      | 31.4                                   | .4998       | 58.912       | 297.45     | 852.6         | 17.17      | 90.31    | 132.2          | 1412.2       | 12.491      | .2598                     | .4094    | 1.7423   | -.967       | 419.9         |  |
| 404.            | 30.1      | 31.7                                   | .5048       | 58.848       | 301.70     | 852.5         | 17.18      | 90.77    | 132.2          | 1427.0       | 12.687      | .2624                     | .4091    | 1.7440   | -.966       | 422.4         |  |
| 405.            | 30.1      | 32.1                                   | .5087       | 58.939       | 303.81     | 852.7         | 17.19      | 90.59    | 132.2          | 1437.1       | 12.751      | .2644                     | .4095    | 1.7409   | -.964       | 424.8         |  |
| 406.            | 30.1      | 32.6                                   | .5127       | 58.926       | 305.26     | 852.7         | 17.19      | 90.33    | 132.2          | 1448.5       | 12.815      | .2665                     | .4094    | 1.7407   | -.960       | 427.0         |  |
| 407.            | 30.1      | 29.6                                   | .4655       | 58.702       | 304.55     | 780.4         | 17.21      | 91.19    | 121.2          | 1317.6       | 11.768      | .2644                     | .4870    | 1.7484   | -.967       | 400.4         |  |
| 408.            | 30.1      | 30.0                                   | .4699       | 58.769       | 306.43     | 780.4         | 17.21      | 90.80    | 121.1          | 1329.2       | 11.820      | .2668                     | .4876    | 1.7460   | -.964       | 402.4         |  |
| 409.            | 30.1      | 30.4                                   | .4728       | 58.710       | 308.18     | 780.5         | 17.22      | 90.85    | 121.2          | 1338.2       | 11.908      | .2685                     | .4869    | 1.7476   | -.964       | 404.4         |  |
| 410.            | 30.1      | 28.7                                   | .4571       | 58.971       | 298.23     | 780.5         | 17.22      | 90.54    | 120.9          | 1290.7       | 11.446      | .2595                     | .4891    | 1.7413   | -.972       | 395.9         |  |
| 411.            | 34.0      | 32.5                                   | .5269       | 58.752       | 376.68     | 700.2         | 17.24      | 89.34    | 108.7          | 1490.7       | 13.044      | .3334                     | .6053    | 1.7460   | -.962       | 435.4         |  |
| 412.            | 34.0      | 32.5                                   | .5317       | 58.724       | 369.83     | 720.8         | 17.25      | 89.51    | 111.9          | 1504.7       | 13.192      | .3269                     | .5710    | 1.7483   | -.958       | 438.4         |  |
| 413.            | 34.0      | 32.5                                   | .5376       | 58.605       | 364.19     | 740.7         | 17.26      | 89.78    | 115.1          | 1522.8       | 13.389      | .3216                     | .5397    | 1.7502   | -.961       | 441.5         |  |
| 414.            | 34.0      | 32.5                                   | .5433       | 58.745       | 360.14     | 760.6         | 17.26      | 89.98    | 118.1          | 1537.2       | 13.547      | .3166                     | .5131    | 1.7461   | -.961       | 445.0         |  |
| 415.            | 34.0      | 32.5                                   | .5490       | 58.852       | 354.91     | 780.4         | 17.26      | 89.88    | 121.0          | 1551.9       | 13.661      | .3118                     | .4883    | 1.7440   | -.968       | 448.4         |  |
| 416.            | 34.0      | 32.5                                   | .5550       | 59.302       | 351.39     | 800.4         | 17.27      | 89.59    | 123.7          | 1563.0       | 13.715      | .3073                     | .4677    | 1.7308   | -.968       | 452.4         |  |
| 417.            | 34.0      | 32.5                                   | .5601       | 59.392       | 343.58     | 820.7         | 17.27      | 88.88    | 126.7          | 1576.2       | 13.721      | .3024                     | .4454    | 1.7275   | -.964       | 455.5         |  |
| 418.            | 34.0      | 33.8                                   | .5652       | 58.817       | 360.81     | 790.2         | 17.29      | 89.93    | 122.6          | 1598.3       | 14.077      | .3170                     | .4758    | 1.7440   | -.962       | 458.4         |  |
| 419.            | 34.0      | 33.8                                   | .5706       | 58.701       | 353.35     | 810.5         | 17.30      | 89.66    | 125.9          | 1615.0       | 14.182      | .3120                     | .4514    | 1.7478   | -.964       | 461.5         |  |
| 420.            | 34.0      | 33.8                                   | .5763       | 58.988       | 349.13     | 830.6         | 17.30      | 89.44    | 128.7          | 1627.3       | 14.255      | .3075                     | .4319    | 1.7392   | -.964       | 465.4         |  |
| 421.            | 34.0      | 33.8                                   | .5819       | 59.017       | 341.23     | 850.7         | 17.31      | 88.62    | 131.8          | 1642.7       | 14.258      | .3032                     | .4120    | 1.7380   | -.962       | 468.4         |  |
| 422.            | 34.0      | 33.8                                   | .5869       | 59.171       | 332.62     | 870.6         | 17.32      | 87.43    | 134.7          | 1654.6       | 14.169      | .2987                     | .3944    | 1.7335   | -.961       | 471.5         |  |
| 423.            | 34.0      | 35.1                                   | .6046       | 59.144       | 361.14     | 840.4         | 17.31      | 88.99    | 130.0          | 1705.0       | 14.860      | .3188                     | .4231    | 1.7340   | -.960       | 482.4         |  |
| 424.            | 34.0      | 35.1                                   | .6087       | 59.003       | 352.71     | 850.7         | 17.32      | 88.63    | 133.3          | 1718.5       | 14.918      | .3134                     | .4023    | 1.7378   | -.958       | 485.4         |  |
| 425.            | 34.0      | 35.1                                   | .6156       | 59.211       | 346.63     | 880.7         | 17.33      | 87.82    | 136.2          | 1734.9       | 14.921      | .3087                     | .3857    | 1.7316   | -.957       | 489.3         |  |
| 426.            | 34.0      | 35.1                                   | .6207       | 59.215       | 337.44     | 900.7         | 17.35      | 86.69    | 139.3          | 1749.4       | 14.853      | .3054                     | .3688    | 1.7313   | -.957       | 492.4         |  |
| 427.            | 34.0      | 35.1                                   | .6239       | 59.103       | 323.79     | 920.6         | 17.36      | 84.77    | 142.5          | 1759.8       | 14.610      | .3003                     | .3523    | 1.7336   | -.951       | 494.3         |  |
| 428.            | 34.0      | 35.1                                   | .6267       | 58.885       | 310.17     | 940.9         | 17.38      | 82.92    | 145.9          | 1771.1       | 14.382      | .2952                     | .3361    | 1.7394   | -.947       | 496.4         |  |

| 328-01<br>Nº 26 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 02 AVR 92<br>Date: |          |          |             |               |
|-----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|
| No              | αp<br>(°) | γd<br>(mm)                                    | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 429.            | 34.0      | 38.1  | .6400       | 59.010       | 375.33     | 850.7         | 17.47      | 88.65    | 131.8          | 1806.8       | 15.687      | .3334                     | .4119    | 1.7372   | -.957       | 504.4         |
| 430.            | 34.0      | 38.1  | .6466       | 58.930       | 369.24     | 870.7         | 17.49      | 88.47    | 135.0          | 1826.6       | 15.827      | .3291                     | .3927    | 1.7397   | -.958       | 508.3         |
| 431.            | 34.0      | 38.1  | .6526       | 59.034       | 363.56     | 890.6         | 17.50      | 88.13    | 137.9          | 1841.9       | 15.897      | .3247                     | .3760    | 1.7359   | -.954       | 512.4         |
| 432.            | 34.0      | 38.1  | .6591       | 59.041       | 357.12     | 910.5         | 17.51      | 87.62    | 141.0          | 1860.1       | 15.963      | .3208                     | .3598    | 1.7351   | -.951       | 516.4         |
| 433.            | 34.0      | 38.1  | .6664       | 59.034       | 350.46     | 930.5         | 17.52      | 86.92    | 144.1          | 1881.0       | 16.011      | .3174                     | .3445    | 1.7351   | -.949       | 520.3         |
| 434.            | 34.0      | 38.1  | .6722       | 59.016       | 343.91     | 950.5         | 17.53      | 86.40    | 147.2          | 1897.5       | 16.056      | .3134                     | .3300    | 1.7352   | -.947       | 524.3         |
| 435.            | 34.0      | 38.1  | .6799       | 59.346       | 340.19     | 970.6         | 17.55      | 85.80    | 149.9          | 1914.1       | 16.084      | .3104                     | .3183    | 1.7250   | -.944       | 529.3         |
| 436.            | 34.0      | 38.1  | .6854       | 58.999       | 328.84     | 990.8         | 17.62      | 84.49    | 153.5          | 1935.0       | 16.011      | .3066                     | .3036    | 1.7347   | -.942       | 532.3         |
| 437.            | 34.0      | 39.9  | .6904       | 58.851       | 357.56     | 940.4         | 17.72      | 86.78    | 145.9          | 1951.6       | 16.586      | .3253                     | .3362    | 1.7399   | -.948       | 535.4         |
| 438.            | 34.0      | 39.9  | .6842       | 58.922       | 364.30     | 920.4         | 17.74      | 87.22    | 142.7          | 1933.1       | 16.511      | .3294                     | .3514    | 1.7386   | -.953       | 531.4         |
| 439.            | 34.0      | 39.9  | .6952       | 58.349       | 346.78     | 960.5         | 17.76      | 86.11    | 149.6          | 1973.6       | 16.643      | .3207                     | .3195    | 1.7540   | -.943       | 538.3         |
| 440.            | 34.0      | 39.9  | .7024       | 58.186       | 339.03     | 980.9         | 17.77      | 85.32    | 153.0          | 1997.0       | 16.886      | .3174                     | .3055    | 1.7587   | -.942       | 542.5         |
| 441.            | 34.0      | 39.9  | .7103       | 58.386       | 334.25     | 1000.8        | 17.78      | 84.59    | 155.9          | 2015.8       | 16.698      | .3145                     | .2945    | 1.7521   | -.939       | 547.4         |
| 442.            | 34.0      | 35.2  | .6076       | 58.887       | 354.55     | 852.7         | 17.86      | 88.61    | 132.2          | 1717.1       | 14.900      | .3158                     | .4091    | 1.7404   | -.959       | 483.8         |
| 443.            | 34.0      | 35.9  | .6157       | 58.766       | 359.13     | 852.7         | 17.88      | 88.76    | 132.4          | 1741.8       | 15.139      | .3200                     | .4083    | 1.7439   | -.959       | 488.9         |
| 444.            | 34.0      | 36.5  | .6232       | 58.854       | 364.32     | 852.6         | 17.90      | 88.81    | 132.3          | 1761.6       | 15.322      | .3239                     | .4090    | 1.7408   | -.956       | 493.4         |
| 445.            | 34.0      | 37.1  | .6291       | 58.792       | 367.41     | 852.6         | 17.91      | 88.81    | 132.3          | 1779.4       | 15.476      | .3270                     | .4085    | 1.7429   | -.957       | 497.4         |
| 446.            | 34.0      | 37.7  | .6373       | 59.043       | 373.35     | 852.7         | 17.93      | 88.72    | 132.1          | 1798.7       | 15.627      | .3312                     | .4102    | 1.7356   | -.959       | 502.4         |
| 447.            | 34.0      | 38.3  | .6436       | 59.029       | 375.74     | 852.7         | 17.94      | 88.44    | 132.1          | 1816.6       | 15.733      | .3345                     | .4101    | 1.7356   | -.956       | 506.4         |
| 448.            | 34.0      | 31.6  | .5398       | 58.746       | 346.81     | 780.5         | 17.99      | 89.51    | 121.2          | 1527.3       | 13.387      | .3055                     | .4873    | 1.7452   | -.965       | 443.0         |
| 449.            | 34.0      | 32.0  | .5443       | 58.849       | 350.42     | 780.5         | 17.99      | 89.54    | 121.1          | 1538.7       | 13.492      | .3090                     | .4880    | 1.7424   | -.966       | 445.5         |
| 450.            | 34.0      | 32.4  | .5498       | 58.743       | 354.10     | 780.5         | 18.00      | 89.75    | 121.2          | 1555.6       | 13.672      | .3121                     | .4871    | 1.7457   | -.967       | 448.5         |
| 451.            | 34.0      | 32.9  | .5550       | 58.781       | 357.75     | 780.6         | 18.01      | 89.77    | 121.2          | 1569.8       | 13.800      | .3151                     | .4874    | 1.7443   | -.965       | 451.5         |
| 452.            | 34.0      | 33.4  | .5599       | 58.624       | 360.09     | 780.6         | 18.02      | 89.80    | 121.3          | 1585.8       | 13.946      | .3179                     | .4861    | 1.7485   | -.963       | 454.5         |
| 453.            | 34.0      | 33.9  | .5650       | 58.756       | 364.07     | 780.5         | 18.02      | 89.76    | 121.2          | 1598.6       | 14.051      | .3208                     | .4873    | 1.7442   | -.960       | 457.9         |
| 454.            | 34.0      | 34.2  | .5690       | 58.817       | 366.50     | 780.5         | 18.03      | 89.64    | 121.1          | 1608.9       | 14.123      | .3231                     | .4878    | 1.7437   | -.958       | 460.4         |
| 455.            | 34.0      | 34.6  | .5731       | 58.768       | 367.90     | 780.5         | 18.04      | 89.40    | 121.1          | 1621.2       | 14.193      | .3254                     | .4874    | 1.7436   | -.959       | 462.5         |
| 456.            | 34.0      | 35.3  | .5796       | 58.706       | 370.49     | 780.5         | 18.04      | 89.12    | 121.2          | 1640.5       | 14.317      | .3291                     | .4869    | 1.7445   | -.954       | 466.5         |

|               |        |                     |   |
|---------------|--------|---------------------|---|
| GABRIEL TERRA | U.T.E. | GEC ALSTHOM NEYRPEC | <br>IMHIEF<br>INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE |
|---------------|--------|---------------------|---|



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE


GEC ALSTHOM NEYRPI

U.T.E.

GABRIEL TERRA

pour E et P

| 328-01<br>Nº 27 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 02 AVR 92<br>Date: |          |          |             |               |
|-----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|
| No              | αp<br>(º) | γd<br>(mm)                                    | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(ºC) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 457.            | 6.0       | 9.9   | .0897       | 58.546       | 57.66      | 660.4         | 17.79      | 76.05    | 102.7          | 254.2        | 1.893       | .0602                     | .6782    | 1.7574   | -.989       | 249.4         |
| 458.            | 6.0       | 9.9   | .0904       | 58.568       | 54.98      | 680.4         | 17.79      | 74.13    | 105.8          | 256.0        | 1.859       | .0589                     | .6391    | 1.7550   | -.989       | 249.4         |
| 459.            | 6.0       | 9.9   | .0904       | 58.544       | 56.14      | 680.4         | 17.80      | 75.68    | 105.8          | 256.2        | 1.899       | .0589                     | .6389    | 1.7556   | -.988       | 249.4         |
| 460.            | 6.0       | 9.9   | .0910       | 58.414       | 54.77      | 700.4         | 17.78      | 75.67    | 109.0          | 258.2        | 1.913       | .0576                     | .6016    | 1.7598   | -.989       | 249.4         |
| 461.            | 6.0       | 9.9   | .0920       | 58.791       | 54.22      | 720.6         | 17.77      | 75.75    | 111.8          | 260.2        | 1.930       | .0566                     | .5720    | 1.7484   | -.989       | 250.4         |
| 462.            | 6.0       | 9.9   | .0925       | 58.776       | 52.94      | 740.6         | 17.77      | 75.61    | 114.9          | 261.7        | 1.938       | .0554                     | .5414    | 1.7488   | -.989       | 250.4         |
| 463.            | 6.0       | 9.9   | .0934       | 59.086       | 51.78      | 760.5         | 17.77      | 74.80    | 117.7          | 263.6        | 1.931       | .0544                     | .5161    | 1.7398   | -.989       | 251.4         |
| 464.            | 6.0       | 9.9   | .0940       | 58.858       | 50.27      | 780.5         | 17.76      | 74.35    | 121.1          | 265.7        | 1.935       | .0534                     | .4881    | 1.7465   | -.989       | 251.4         |
| 465.            | 6.0       | 9.9   | .0952       | 58.790       | 47.79      | 810.4         | 17.75      | 72.57    | 125.8          | 269.2        | 1.913       | .0521                     | .4522    | 1.7486   | -.990       | 251.4         |
| 466.            | 6.0       | 9.9   | .0978       | 58.931       | 43.21      | 870.4         | 17.75      | 68.41    | 134.9          | 276.3        | 1.851       | .0498                     | .3930    | 1.7442   | -.989       | 252.4         |
| 467.            | 6.0       | 9.9   | .0907       | 58.413       | 55.41      | 690.5         | 17.74      | 75.76    | 107.5          | 257.3        | 1.909       | .0582                     | .6190    | 1.7598   | -.989       | 249.4         |
| 468.            | 6.0       | 9.9   | .0902       | 58.615       | 57.20      | 670.3         | 17.74      | 76.07    | 104.2          | 255.4        | 1.903       | .0596                     | .6590    | 1.7537   | -.989       | 249.4         |
| 469.            | 6.0       | 12.4  | .1021       | 58.861       | 56.24      | 750.5         | 17.72      | 73.63    | 116.4          | 288.6        | 2.081       | .0603                     | .5279    | 1.7464   | -.989       | 253.4         |
| 470.            | 6.0       | 12.4  | .1036       | 59.054       | 54.50      | 780.4         | 17.72      | 72.87    | 120.8          | 292.5        | 2.087       | .0589                     | .4899    | 1.7408   | -.989       | 254.4         |
| 471.            | 6.0       | 12.4  | .1053       | 59.287       | 52.86      | 810.6         | 17.71      | 71.99    | 125.3          | 296.5        | 2.090       | .0575                     | .4558    | 1.7339   | -.989       | 255.4         |
| 472.            | 6.0       | 12.4  | .1067       | 59.157       | 51.12      | 840.4         | 17.71      | 71.37    | 130.0          | 300.9        | 2.103       | .0563                     | .4231    | 1.7377   | -.989       | 255.4         |
| 473.            | 6.0       | 12.4  | .1072       | 58.495       | 48.64      | 860.4         | 17.71      | 69.99    | 133.9          | 303.9        | 2.083       | .0552                     | .3992    | 1.7573   | -.989       | 254.4         |
| 474.            | 6.0       | 12.4  | .1081       | 58.746       | 46.83      | 880.4         | 17.70      | 68.06    | 136.7          | 305.9        | 2.039       | .0544                     | .3829    | 1.7499   | -.989       | 255.1         |
| 475.            | 6.0       | 12.4  | .1085       | 58.759       | 44.68      | 900.6         | 17.70      | 66.18    | 139.8          | 307.0        | 1.990       | .0534                     | .3660    | 1.7496   | -.990       | 255.4         |
| 476.            | 6.0       | 12.4  | .1096       | 59.141       | 42.75      | 920.7         | 17.70      | 63.65    | 142.5          | 309.2        | 1.927       | .0528                     | .3524    | 1.7382   | -.989       | 256.4         |
| 477.            | 6.0       | 12.4  | .1100       | 59.076       | 40.27      | 940.6         | 17.69      | 61.12    | 145.6          | 310.3        | 1.858       | .0518                     | .3374    | 1.7400   | -.989       | 256.4         |
| 478.            | 6.0       | 12.4  | .1108       | 59.110       | 39.07      | 950.5         | 17.69      | 59.45    | 147.1          | 312.6        | 1.820       | .0517                     | .3306    | 1.7391   | -.989       | 256.4         |
| 479.            | 6.0       | 15.0  | .1160       | 58.562       | 48.65      | 880.3         | 17.68      | 66.12    | 136.9          | 328.7        | 2.128       | .0584                     | .3818    | 1.7555   | -.989       | 257.4         |
| 480.            | 6.0       | 15.0  | .1168       | 58.851       | 46.75      | 900.7         | 17.68      | 64.24    | 139.7          | 330.2        | 2.077       | .0575                     | .3665    | 1.7468   | -.989       | 258.4         |
| 481.            | 6.0       | 15.0  | .1177       | 58.862       | 45.00      | 920.8         | 17.68      | 62.70    | 142.8          | 332.8        | 2.043       | .0567                     | .3508    | 1.7464   | -.989       | 258.4         |
| 482.            | 6.0       | 15.0  | .1186       | 58.847       | 42.61      | 940.6         | 17.67      | 60.22    | 145.9          | 335.2        | 1.977       | .0559                     | .3360    | 1.7469   | -.989       | 259.1         |
| 483.            | 6.0       | 15.0  | .1189       | 59.029       | 41.56      | 950.5         | 17.67      | 59.01    | 147.2          | 335.7        | 1.940       | .0554                     | .3301    | 1.7415   | -.989       | 259.4         |
| 484.            | 6.0       | 15.0  | .1196       | 58.993       | 40.47      | 960.5         | 17.67      | 57.77    | 148.8          | 337.7        | 1.911       | .0552                     | .3231    | 1.7426   | -.989       | 259.4         |
| 485.            | 6.0       | 11.6  | .1048       | 58.910       | 49.19      | 852.6         | 17.66      | 71.23    | 132.2          | 296.1        | 2.066       | .0545                     | .4094    | 1.7451   | -.989       | 254.4         |
| 486.            | 6.0       | 12.0  | .1065       | 59.112       | 50.20      | 852.5         | 17.65      | 71.28    | 131.9          | 300.4        | 2.097       | .0554                     | .4109    | 1.7391   | -.989       | 255.4         |
| 487.            | 6.0       | 12.6  | .1082       | 58.871       | 50.78      | 852.5         | 17.65      | 71.28    | 132.2          | 305.7        | 2.134       | .0562                     | .4092    | 1.7462   | -.989       | 255.4         |
| 488.            | 6.0       | 13.0  | .1099       | 58.933       | 51.33      | 852.5         | 17.64      | 70.83    | 132.1          | 310.5        | 2.154       | .0571                     | .4097    | 1.7443   | -.988       | 256.0         |
| 489.            | 6.0       | 13.7  | .1115       | 58.751       | 51.32      | 852.5         | 17.64      | 70.02    | 132.3          | 315.5        | 2.163       | .0580                     | .4084    | 1.7500   | -.990       | 256.4         |
| 490.            | 6.0       | 8.7   | .0893       | 58.749       | 46.98      | 780.5         | 17.63      | 73.32    | 121.2          | 252.5        | 1.813       | .0507                     | .4873    | 1.7500   | -.990       | 249.4         |
| 491.            | 6.0       | 9.2   | .0915       | 58.934       | 48.57      | 780.5         | 17.63      | 73.73    | 121.0          | 258.4        | 1.866       | .0519                     | .4887    | 1.7445   | -.990       | 250.4         |
| 492.            | 6.0       | 9.7   | .0944       | 59.110       | 50.33      | 780.5         | 17.62      | 73.85    | 120.8          | 266.1        | 1.925       | .0536                     | .4902    | 1.7393   | -.989       | 251.4         |
| 493.            | 6.0       | 10.2  | .0960       | 58.821       | 51.10      | 780.6         | 17.62      | 74.07    | 121.1          | 271.4        | 1.969       | .0545                     | .4876    | 1.7478   | -.989       | 251.4         |
| 494.            | 6.0       | 10.7  | .0978       | 58.461       | 52.22      | 780.4         | 17.62      | 74.75    | 121.5          | 277.3        | 2.030       | .0555                     | .4849    | 1.7586   | -.989       | 251.4         |
| 495.            | 6.0       | 11.1  | .0999       | 58.522       | 53.08      | 780.5         | 17.61      | 74.35    | 121.4          | 283.1        | 2.061       | .0567                     | .4853    | 1.7567   | -.989       | 252.4         |



**IMMHEF**  
INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

**GABRIEL TERRA**

**U.T.E.**

**GEC ALSTHOM NEYRPIC**

GABRIEL TERRA

U.T.E.

GEC ALSTHOM NEYRPIC



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*



| 328-01<br>No 29 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |              |              |            |               |            |          |                |              |             | Fecha: 02 AVR 92<br>Date: |          |          |             |               |
|-----------------|-----------|---|--------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|
| No              | αp<br>(°) | γd<br>(mm)                                    | V̇<br>(m³/s) | gH<br>(J/kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 496.            | 6.0       | 11.7  | .1017        | 58.598       | 53.79      | 780.6         | 17.60      | 73.87    | 121.3          | 288.2        | 2.085       | .0577                     | .4859    | 1.7563   | -.990       | 252.8         |
| 497.            | 6.0       | 10.7  | .0979        | 58.524       | 51.97      | 780.6         | 17.60      | 74.27    | 121.4          | 277.5        | 2.018       | .0556                     | .4852    | 1.7567   | -.989       | 251.4         |
| 498.            | 6.0       | 7.9   | .0857        | 58.767       | 37.09      | 852.8         | 17.59      | 65.87    | 132.4          | 242.3        | 1.563       | .0445                     | .4083    | 1.7494   | -.989       | 248.4         |
| 499.            | 6.0       | 9.1   | .0929        | 58.732       | 42.18      | 852.6         | 17.58      | 69.13    | 132.4          | 262.8        | 1.779       | .0483                     | .4081    | 1.7506   | -.989       | 250.4         |
| 500.            | 12.1      | 17.3  | .1812        | 58.693       | 124.43     | 700.4         | 17.50      | 85.92    | 108.8          | 512.9        | 4.316       | .1147                     | .6044    | 1.7513   | -.986       | 284.4         |
| 501.            | 12.1      | 17.3  | .1827        | 58.980       | 122.67     | 720.2         | 17.50      | 85.97    | 111.6          | 515.9        | 4.344       | .1124                     | .5744    | 16.2580  | -.986       | 285.4         |
| 502.            | 12.1      | 17.3  | .1848        | 59.255       | 120.92     | 740.7         | 17.49      | 85.77    | 114.5          | 520.6        | 4.373       | .1106                     | .5456    | 1.7363   | -.985       | 286.3         |
| 503.            | 12.1      | 17.3  | .1855        | 58.948       | 117.81     | 760.6         | 17.49      | 85.91    | 117.9          | 524.0        | 4.409       | .1081                     | .5148    | 1.7439   | -.987       | 286.3         |
| 504.            | 12.1      | 17.3  | .1875        | 59.173       | 116.25     | 780.5         | 17.49      | 85.76    | 120.7          | 528.6        | 4.439       | .1065                     | .4907    | 1.7372   | -.987       | 287.4         |
| 505.            | 12.1      | 17.3  | .1890        | 58.918       | 113.30     | 800.4         | 17.49      | 85.41    | 124.1          | 533.9        | 4.466       | .1046                     | .4646    | 1.7448   | -.987       | 287.4         |
| 506.            | 12.1      | 17.3  | .1906        | 58.912       | 111.79     | 820.3         | 17.49      | 85.63    | 127.2          | 538.6        | 4.516       | .1030                     | .4423    | 1.7468   | -.988       | 287.8         |
| 507.            | 12.1      | 17.3  | .1927        | 58.863       | 109.71     | 840.8         | 17.48      | 85.25    | 130.4          | 544.8        | 4.549       | .1016                     | .4206    | 1.7465   | -.987       | 288.3         |
| 508.            | 12.1      | 17.3  | .1946        | 59.095       | 108.03     | 860.7         | 17.48      | 84.78    | 133.2          | 549.0        | 4.558       | .1002                     | .4030    | 1.7413   | -.987       | 289.4         |
| 509.            | 12.1      | 17.3  | .1974        | 59.011       | 104.18     | 890.6         | 17.48      | 83.50    | 138.0          | 557.4        | 4.558       | .0982                     | .3759    | 1.7422   | -.987       | 289.7         |
| 510.            | 12.1      | 17.3  | .1998        | 59.074       | 100.80     | 920.5         | 17.47      | 82.42    | 142.5          | 563.8        | 4.551       | .0962                     | .3522    | 1.7420   | -.987       | 290.3         |
| 511.            | 12.1      | 19.8  | .2077        | 58.853       | 112.11     | 880.6         | 17.44      | 84.67    | 136.6          | 587.2        | 4.869       | .1045                     | .3835    | 1.7468   | -.987       | 291.3         |
| 512.            | 12.1      | 19.8  | .2103        | 59.177       | 111.05     | 900.5         | 17.44      | 84.24    | 139.3          | 592.9        | 4.892       | .1035                     | .3687    | 1.7373   | -.987       | 292.3         |
| 513.            | 12.1      | 19.8  | .2125        | 58.993       | 108.53     | 920.4         | 17.44      | 83.57    | 142.6          | 599.9        | 4.910       | .1023                     | .3518    | 1.7442   | -.986       | 292.3         |
| 514.            | 12.1      | 19.8  | .2148        | 59.252       | 107.21     | 940.9         | 17.43      | 83.08    | 145.4          | 605.3        | 4.925       | .1012                     | .3382    | 1.7368   | -.987       | 293.3         |
| 515.            | 12.1      | 19.8  | .2166        | 59.073       | 104.46     | 960.8         | 17.43      | 82.23    | 148.8          | 611.2        | 4.923       | .0999                     | .3233    | 1.7419   | -.986       | 293.3         |
| 516.            | 12.1      | 19.8  | .2188        | 58.916       | 101.34     | 980.7         | 17.43      | 80.84    | 152.0          | 618.1        | 4.894       | .0989                     | .3095    | 1.7466   | -.986       | 293.3         |
| 517.            | 12.1      | 19.8  | .2204        | 58.810       | 98.13      | 1000.6        | 17.43      | 79.44    | 155.3          | 623.2        | 4.848       | .0976                     | .2968    | 1.7480   | -.986       | 293.4         |
| 518.            | 12.1      | 19.8  | .2222        | 58.533       | 94.35      | 1020.8        | 17.42      | 77.66    | 158.8          | 629.7        | 4.790       | .0964                     | .2838    | 1.7581   | -.987       | 293.3         |
| 519.            | 12.1      | 22.5  | .2279        | 58.938       | 106.85     | 960.7         | 17.42      | 80.12    | 148.9          | 643.9        | 5.052       | .1051                     | .3227    | 1.7440   | -.985       | 295.3         |
| 520.            | 12.1      | 22.5  | .2295        | 58.680       | 104.09     | 980.7         | 17.42      | 79.48    | 152.3          | 649.7        | 5.057       | .1037                     | .3083    | 1.7536   | -.986       | 295.3         |
| 521.            | 12.1      | 22.5  | .2325        | 58.785       | 102.31     | 1000.5        | 17.42      | 78.52    | 155.3          | 657.7        | 5.058       | .1030                     | .2967    | 1.7504   | -.986       | 296.3         |
| 522.            | 12.1      | 22.5  | .2348        | 58.472       | 99.76      | 1020.5        | 17.42      | 77.74    | 158.8          | 666.0        | 5.071       | .1020                     | .2836    | 1.7596   | -.985       | 296.3         |
| 523.            | 12.1      | 22.5  | .2375        | 58.589       | 97.30      | 1040.9        | 17.42      | 76.31    | 161.8          | 672.9        | 5.029       | .1011                     | .2732    | 1.7545   | -.985       | 297.3         |
| 524.            | 12.1      | 22.5  | .2398        | 58.704       | 95.20      | 1060.8        | 17.41      | 75.22    | 164.7          | 678.7        | 5.000       | .1002                     | .2636    | 1.7528   | -.985       | 298.2         |
| 525.            | 12.1      | 15.0  | .1708        | 58.982       | 125.17     | 660.5         | 17.41      | 86.04    | 102.3          | 482.4        | 4.065       | .1146                     | .6829    | 1.7447   | -.986       | 281.3         |
| 526.            | 12.1      | 15.0  | .1721        | 58.768       | 122.02     | 680.5         | 17.40      | 86.09    | 105.6          | 486.8        | 4.105       | .1121                     | .6411    | 1.7494   | -.987       | 281.3         |
| 527.            | 12.1      | 15.0  | .1726        | 58.550       | 119.19     | 700.3         | 17.40      | 86.60    | 108.9          | 489.2        | 4.149       | .1092                     | .6031    | 1.7578   | -.988       | 281.3         |
| 528.            | 12.1      | 15.0  | .1746        | 58.731       | 116.49     | 720.2         | 17.40      | 85.80    | 111.8          | 494.0        | 4.151       | .1074                     | .5720    | 1.7507   | -.988       | 282.3         |
| 529.            | 12.1      | 15.0  | .1727        | 58.701       | 120.24     | 690.5         | 17.40      | 85.87    | 107.2          | 488.8        | 4.111       | .1108                     | .6220    | 1.7532   | -.987       | 281.3         |
| 530.            | 12.1      | 15.0  | .1732        | 58.554       | 118.72     | 700.3         | 17.39      | 85.96    | 108.9          | 490.9        | 4.133       | .1096                     | .6031    | 1.7560   | -.988       | 281.3         |
| 531.            | 12.1      | 15.0  | .1760        | 58.523       | 114.33     | 740.7         | 17.39      | 86.19    | 115.2          | 499.1        | 4.213       | .1053                     | .5389    | 1.7569   | -.988       | 282.3         |
| 532.            | 12.1      | 15.0  | .1778        | 58.691       | 113.12     | 760.6         | 17.39      | 86.43    | 118.1          | 503.4        | 4.261       | .1036                     | .5126    | 1.7520   | -.988       | 283.3         |
| 533.            | 12.1      | 15.0  | .1795        | 58.888       | 110.86     | 780.5         | 17.38      | 85.82    | 121.0          | 507.3        | 4.264       | .1019                     | .4884    | 1.7461   | -.988       | 284.3         |

GABRIEL TERRA

U.T.E.

GEC ALSTHOM NEYRPIC


 INSTITUT DE MACHINES HYDRAULIQUES  
 ET DE MECANIQUE DES FLUIDES  
 ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE

Pour E.D.F.

| 328-01<br>Nº 31 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 02 Avr 92<br>Date: |          |          |             |               |
|-----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|
| No              | αp<br>(°) | χd<br>(mm)                                    | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 534.            | 12.1      | 15.0  | .1807       | 58.744       | 107.64     | 800.3         | 17.38      | 85.08    | 124.3          | 511.3        | 4.261       | .1001                     | .4634    | 1.7503   | -.988       | 284.3         |
| 535.            | 12.1      | 15.0  | .1822       | 58.939       | 105.10     | 820.7         | 17.38      | 84.23    | 127.2          | 514.7        | 4.245       | .0984                     | .4421    | 1.7445   | -.987       | 285.3         |
| 536.            | 12.1      | 13.4  | .1673       | 58.706       | 99.63      | 780.4         | 17.36      | 83.02    | 121.2          | 473.5        | 3.850       | .0950                     | .4870    | 1.7514   | -.987       | 279.3         |
| 537.            | 12.1      | 13.9  | .1710       | 58.777       | 103.23     | 780.5         | 17.36      | 84.07    | 121.1          | 483.6        | 3.982       | .0971                     | .4874    | 1.7511   | -.988       | 280.9         |
| 538.            | 12.1      | 14.4  | .1744       | 58.711       | 106.48     | 780.4         | 17.36      | 85.10    | 121.2          | 493.6        | 4.114       | .0990                     | .4870    | 1.7515   | -.989       | 282.3         |
| 539.            | 12.1      | 14.8  | .1780       | 58.668       | 109.11     | 780.4         | 17.36      | 85.50    | 121.2          | 504.0        | 4.220       | .1011                     | .4867    | 1.7527   | -.988       | 283.3         |
| 540.            | 12.1      | 15.4  | .1816       | 58.674       | 112.41     | 780.4         | 17.35      | 86.34    | 121.2          | 514.0        | 4.347       | .1031                     | .4868    | 1.7524   | -.987       | 284.6         |
| 541.            | 12.1      | 16.5  | .1873       | 58.567       | 116.33     | 780.4         | 17.35      | 86.77    | 121.3          | 530.8        | 4.511       | .1064                     | .4858    | 1.7572   | -.987       | 286.3         |
| 542.            | 12.1      | 17.4  | .1926       | 58.534       | 119.20     | 780.4         | 17.35      | 86.53    | 121.4          | 545.8        | 4.626       | .1094                     | .4856    | 1.7566   | -.987       | 287.8         |
| 543.            | 12.1      | 18.4  | .1973       | 58.770       | 122.74     | 780.5         | 17.34      | 86.62    | 121.2          | 558.2        | 4.735       | .1120                     | .4874    | 1.7493   | -.986       | 289.2         |
| 542.            | 12.1      | 19.2  | .2014       | 58.926       | 125.29     | 780.4         | 17.34      | 86.39    | 121.0          | 568.9        | 4.814       | .1144                     | .4889    | 1.7444   | -.984       | 290.3         |
| 543.            | 12.1      | 14.3  | .1787       | 58.976       | 95.68      | 852.5         | 17.33      | 81.14    | 132.1          | 504.7        | 4.010       | .0929                     | .4100    | 1.7434   | -.987       | 284.3         |
| 544.            | 12.1      | 15.0  | .1840       | 58.933       | 99.89      | 852.5         | 17.33      | 82.34    | 132.1          | 519.7        | 4.192       | .0956                     | .4097    | 1.7446   | -.987       | 285.9         |
| 545.            | 12.1      | 15.9  | .1898       | 58.896       | 104.70     | 852.5         | 17.32      | 83.73    | 132.2          | 536.2        | 4.398       | .0986                     | .4094    | 1.7459   | -.988       | 287.6         |
| 546.            | 12.1      | 16.7  | .1950       | 58.975       | 109.47     | 852.6         | 17.32      | 85.11    | 132.1          | 550.6        | 4.589       | .1013                     | .4099    | 1.7435   | -.987       | 289.2         |
| 547.            | 12.1      | 17.7  | .2005       | 58.933       | 114.04     | 852.6         | 17.32      | 86.28    | 132.2          | 566.4        | 4.786       | .1042                     | .4096    | 1.7449   | -.988       | 290.3         |
| 548.            | 12.1      | 18.5  | .2051       | 59.037       | 116.42     | 852.6         | 17.31      | 85.97    | 132.1          | 578.8        | 4.874       | .1066                     | .4102    | 1.7417   | -.987       | 291.3         |
| 549.            | 12.1      | 19.3  | .2091       | 58.777       | 117.68     | 852.6         | 17.30      | 85.60    | 132.3          | 591.4        | 4.958       | .1087                     | .4085    | 1.7510   | -.987       | 291.3         |
| 550.            | 12.1      | 20.3  | .2132       | 58.876       | 119.88     | 852.6         | 17.30      | 85.36    | 132.2          | 602.7        | 5.038       | .1108                     | .4092    | 1.7462   | -.985       | 292.3         |
| 551.            | 12.1      | 17.7  | .2010       | 58.870       | 114.31     | 852.5         | 17.29      | 86.33    | 132.2          | 568.2        | 4.804       | .1045                     | .4092    | 1.7467   | -.987       | 290.3         |
| 552.            | 12.1      | 17.7  | .2030       | 58.781       | 112.31     | 870.5         | 17.28      | 85.92    | 135.1          | 574.1        | 4.832       | .1033                     | .3918    | 1.7494   | -.987       | 290.3         |
| 553.            | 12.1      | 17.7  | .2050       | 59.035       | 110.72     | 890.4         | 17.28      | 85.43    | 137.9          | 578.5        | 4.840       | .1020                     | .3762    | 1.7418   | -.987       | 291.3         |
| 554.            | 12.1      | 17.7  | .2069       | 58.895       | 107.71     | 910.7         | 17.27      | 84.42    | 141.2          | 584.6        | 4.833       | .1007                     | .3588    | 1.7458   | -.987       | 291.3         |
| 555.            | 12.1      | 17.7  | .2091       | 59.244       | 105.89     | 930.8         | 17.27      | 83.44    | 143.9          | 589.1        | 4.814       | .0995                     | .3455    | 1.7365   | -.986       | 292.3         |
| 556.            | 12.1      | 17.7  | .2109       | 59.091       | 102.72     | 950.7         | 17.27      | 82.17    | 147.2          | 594.9        | 4.788       | .0983                     | .3303    | 1.7400   | -.986       | 292.3         |
| 557.            | 12.1      | 17.7  | .1922       | 58.857       | 124.76     | 750.6         | 17.26      | 86.81    | 116.4          | 543.2        | 4.619       | .1135                     | .5278    | 1.7469   | -.986       | 288.2         |
| 558.            | 12.1      | 17.7  | .1936       | 58.662       | 121.93     | 770.5         | 17.26      | 86.74    | 119.7          | 548.1        | 4.657       | .1113                     | .4992    | 1.7528   | -.987       | 288.2         |
| 559.            | 12.1      | 17.7  | .1951       | 58.509       | 119.17     | 790.4         | 17.26      | 86.52    | 123.0          | 553.1        | 4.687       | .1094                     | .4731    | 1.7574   | -.987       | 288.2         |
| 560.            | 12.1      | 17.7  | .1972       | 58.774       | 117.89     | 810.3         | 17.26      | 86.41    | 125.8          | 557.9        | 4.721       | .1079                     | .4522    | 1.7496   | -.987       | 289.3         |
| 561.            | 12.1      | 17.7  | .1991       | 58.646       | 115.74     | 830.6         | 17.26      | 86.34    | 129.1          | 563.7        | 4.767       | .1062                     | .4294    | 1.7535   | -.988       | 289.2         |
| 562.            | 12.1      | 17.7  | .2008       | 58.871       | 114.44     | 850.7         | 17.25      | 86.35    | 131.9          | 567.6        | 4.800       | .1046                     | .4109    | 1.7468   | -.988       | 290.3         |
| 563.            | 12.1      | 17.3  | .1866       | 58.767       | 129.28     | 700.3         | 17.24      | 86.58    | 108.7          | 527.8        | 4.476       | .1181                     | .6054    | 1.7496   | -.986       | 286.3         |
| 564.            | 12.1      | 17.3  | .1879       | 58.980       | 127.34     | 720.5         | 17.23      | 86.79    | 111.6          | 530.6        | 4.511       | .1156                     | .5741    | 1.7433   | -.986       | 287.3         |
| 565.            | 12.1      | 17.3  | .1894       | 58.757       | 123.93     | 740.7         | 17.23      | 86.49    | 115.0          | 535.8        | 4.538       | .1133                     | .5411    | 1.7499   | -.986       | 287.3         |
| 566.            | 12.1      | 17.3  | .1909       | 58.558       | 121.29     | 760.6         | 17.23      | 86.51    | 118.3          | 541.1        | 4.585       | .1113                     | .5114    | 1.7559   | -.986       | 287.3         |
| 567.            | 12.1      | 17.3  | .1930       | 58.787       | 119.45     | 780.5         | 17.23      | 86.17    | 121.1          | 545.8        | 4.606       | .1096                     | .4876    | 1.7491   | -.986       | 288.3         |
| 568.            | 12.1      | 17.3  | .1949       | 59.003       | 118.03     | 800.4         | 17.23      | 86.15    | 124.0          | 550.1        | 4.642       | .1079                     | .4654    | 1.7428   | -.987       | 289.3         |
| 569.            | 12.1      | 17.3  | .1963       | 58.807       | 115.75     | 820.3         | 17.23      | 86.27    | 127.3          | 555.0        | 4.689       | .1060                     | .4415    | 1.7503   | -.987       | 289.3         |
| 570.            | 12.1      | 17.3  | .1983       | 58.834       | 114.02     | 840.8         | 17.22      | 86.16    | 130.4          | 560.6        | 4.731       | .1045                     | .4204    | 1.7479   | -.988       | 289.6         |



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MECANIQUE DES FLUIDES  
ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE

GEC ALSTHOM NEYRPIC


U.T.E.

GABRIEL TERRA

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

| 328-01<br>Nº 32 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |             |              |            |               |            |          |                |              |             | Fecha: 02 Avr 92<br>Date: |          |          |             |               |  |  |
|-----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|--|--|
| No              | αp<br>(°) | γd<br>(mm)                                    | Ṽ<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |  |  |
| 571.            | 12.1      | 17.3  | .2004       | 58.961       | 112.25     | 860.7         | 17.22      | 85.71    | 133.4          | 566.1        | 4.752       | .1032                     | .4021    | 1.7441   | -.987       | 290.3         |  |  |
| 572.            | 12.1      | 17.3  | .2018       | 58.837       | 109.30     | 880.6         | 17.22      | 84.98    | 136.6          | 570.7        | 4.750       | .1016                     | .3833    | 1.7495   | -.987       | 290.3         |  |  |
| 573.            | 12.1      | 16.6  | .1832       | 58.782       | 124.61     | 710.3         | 17.21      | 86.17    | 110.2          | 518.2        | 4.374       | .1143                     | .5886    | 1.7492   | -.986       | 285.3         |  |  |
| 574.            | 12.1      | 16.6  | .1848       | 58.581       | 121.73     | 730.5         | 17.21      | 86.15    | 113.6          | 523.5        | 4.417       | .1121                     | .5546    | 1.7554   | -.987       | 285.3         |  |  |
| 576.            | 12.1      | 16.6  | .1864       | 58.814       | 120.45     | 750.6         | 17.21      | 86.46    | 116.5          | 527.2        | 4.464       | .1101                     | .5273    | 1.7501   | -.987       | 286.3         |  |  |
| 577.            | 12.1      | 16.6  | .1876       | 58.558       | 117.47     | 770.5         | 17.20      | 86.40    | 119.8          | 531.6        | 4.498       | .1079                     | .4983    | 1.7579   | -.988       | 286.3         |  |  |
| 578.            | 12.1      | 16.6  | .1896       | 58.755       | 116.12     | 790.4         | 17.20      | 86.39    | 122.7          | 536.4        | 4.538       | .1063                     | .4751    | 1.7519   | -.987       | 287.3         |  |  |
| 579.            | 12.1      | 16.6  | .1887       | 58.911       | 117.36     | 780.5         | 17.20      | 86.39    | 121.0          | 533.2        | 4.511       | .1071                     | .4886    | 1.7473   | -.987       | 287.3         |  |  |
| 580.            | 12.1      | 16.6  | .2030       | 58.949       | 95.89      | 948.5         | 17.19      | 79.70    | 147.0          | 573.4        | 4.476       | .0948                     | .3310    | 1.7459   | -.985       | 290.7         |  |  |
| 581.            | 12.1      | 17.6  | .2097       | 59.150       | 102.99     | 948.8         | 17.18      | 82.59    | 146.8          | 591.4        | 4.783       | .0980                     | .3319    | 1.7402   | -.986       | 292.3         |  |  |
| 582.            | 12.1      | 18.3  | .2142       | 59.106       | 105.52     | 949.0         | 17.19      | 82.92    | 146.9          | 604.3        | 4.908       | .1000                     | .3316    | 1.7413   | -.985       | 292.9         |  |  |
| 583.            | 12.1      | 19.2  | .2185       | 58.864       | 107.73     | 948.5         | 17.18      | 83.27    | 147.1          | 617.7        | 5.038       | .1021                     | .3306    | 1.7486   | -.987       | 293.3         |  |  |
| 584.            | 12.1      | 20.2  | .2235       | 58.866       | 109.63     | 948.5         | 17.18      | 82.85    | 147.1          | 631.8        | 5.127       | .1044                     | .3306    | 1.7484   | -.986       | 294.3         |  |  |
| 585.            | 12.1      | 21.0  | .2273       | 58.902       | 111.01     | 948.5         | 17.18      | 82.45    | 147.1          | 642.3        | 5.187       | .1062                     | .3308    | 1.7457   | -.986       | 295.3         |  |  |
| 586.            | 12.1      | 19.1  | .2134       | 58.850       | 112.75     | 900.4         | 17.16      | 84.74    | 139.7          | 603.4        | 5.008       | .1051                     | .3667    | 1.7492   | -.987       | 292.3         |  |  |
| 587.            | 12.1      | 19.1  | .2153       | 58.721       | 110.44     | 920.7         | 17.16      | 84.32    | 143.0          | 609.4        | 5.032       | .1036                     | .3500    | 1.7530   | -.987       | 292.3         |  |  |
| 588.            | 12.1      | 19.1  | .2171       | 58.560       | 107.25     | 940.8         | 17.16      | 83.22    | 146.3          | 615.2        | 5.014       | .1023                     | .3342    | 1.7578   | -.987       | 292.3         |  |  |
| 589.            | 12.1      | 19.1  | .2197       | 58.816       | 105.02     | 960.7         | 17.16      | 81.86    | 149.1          | 621.3        | 4.981       | .1014                     | .3220    | 1.7501   | -.987       | 293.3         |  |  |
| GABRIEL TERRA   |           | U.T.E.  |             |              |            |               |            |          |                |              |             | GEC ALSTHOM NEYRPEC       |          |          |             |               |  <b>IMHEF</b><br>INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE |  |

pour Eaf Photos

*[Signature]*

*[Signature]*

*[Signature]*



328-01-33

GABRIEL TERRA

02 Avr 92

Rendement

Roue : 5-KN-35

20:48:03

## PARAMETRES D'ESSAI

|                      |         | Pentes          | Ordonnees |
|----------------------|---------|-----------------|-----------|
| TEMPERATURE          | gamme 1 | 9.88410         | -.04160   |
| DEBIT 1              | gamme 1 | .04405          | .30204    |
| (turbine)            | gamme 2 | .30119          | .02699    |
|                      | gamme 3 | .00000          | .00000    |
| DEBIT 1              | gamme 1 | .00000          | .00000    |
| (pompe)              | gamme 2 | .00000          | .00000    |
|                      | gamme 3 | .00000          | .00000    |
| ENERGIE              | gamme 1 | .08170          | .11930    |
| (PD1)                | gamme 2 | .00000          | .00000    |
| CAVITATION           | gamme 1 | .08250          | .10312    |
|                      | gamme 2 | .08239          | -.06490   |
|                      | gamme 3 | .00000          | .00000    |
| COUPLE 2             | gamme 1 | 24.80748        | .19442    |
|                      | gamme 2 | .00000          | .00000    |
| COUPLE FROT.         | Stand 2 | .91743          | .14606    |
| POUSSEE AX.          | gamme 1 | .00000          | .00000    |
| COEFFICIENT DE GAMME |         | 2 1 0 1 2 6 2 1 |           |

## CONSTANTES

|                        |         |          |            |          |
|------------------------|---------|----------|------------|----------|
| RAYON DE CEINTURE      | C-1e    | .19000   | R1i        | .00000   |
| SECTIONS               | Amont   | .23646   | Aval       | .60690   |
| ACC. TERRESTRE         | Univ.   | 9.80665  | Locale     | 9.80630  |
| DIAM. STATORS          | Stand 1 | 1.27985  | Stand 2    | 1.08020  |
| R CAPT. FROT.          | Stand 1 | .26585   | Stand 2    | .26465   |
| MASSE PLATEAUX         | Stand 1 | 20.18490 | Stand 2    | 20.18470 |
| MASSE ADDITION.        | [kg]    | 40.00000 | u PIEZO    | 998.50   |
| (uHg-uH2O)g            | Chute   | 123026.7 | Haut. asp. | 123044.4 |
| DIAM. REFERENCE        |         | .00000   | VIT. REF.  | .00000   |
| PRESSION ATM. CORRIGEE |         | 94700.0  |            |          |

FICHER : TERR06.DAT Dernier enregistrement : 89

pour EDF

Pour UTE.

pour NP

| 328-01<br>Nº 34 |           | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |              |              |            |               |            |          |                |              |             | Fecha: 03 Avr 92<br>Date: |          |          |             |               |  |
|-----------------|-----------|---|--------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|---------------------------|----------|----------|-------------|---------------|--|
| No              | αp<br>(°) | γd<br>(mm)                                    | V̇<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-)                  | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |  |
| 590.            | 18.0      | 19.4  | .2524        | 58.878       | 162.25     | 780.6         | 16.90      | 89.34    | 121.1          | 713.4        | 6.243       | .1433                     | .4882    | 1.7531   | -.982       | 302.3         |  |
| 591.            | 18.0      | 20.3  | .2582        | 58.700       | 167.08     | 780.7         | 16.90      | 90.22    | 121.3          | 730.9        | 6.459       | .1466                     | .4866    | 1.7589   | -.985       | 303.9         |  |
| 592.            | 18.0      | 20.6  | .2609        | 58.763       | 168.83     | 780.7         | 16.90      | 90.12    | 121.2          | 738.2        | 6.516       | .1481                     | .4871    | 1.7570   | -.985       | 304.7         |  |
| 593.            | 18.0      | 21.2  | .2646        | 58.670       | 170.64     | 780.8         | 16.89      | 89.98    | 121.3          | 749.2        | 6.603       | .1502                     | .4862    | 1.7596   | -.984       | 305.8         |  |
| 594.            | 18.0      | 21.8  | .2687        | 58.705       | 173.05     | 780.8         | 16.89      | 89.79    | 121.3          | 760.7        | 6.690       | .1525                     | .4865    | 1.7587   | -.984       | 307.2         |  |
| 595.            | 18.0      | 22.5  | .2726        | 58.729       | 175.64     | 780.3         | 16.89      | 89.74    | 121.2          | 771.5        | 6.781       | .1548                     | .4873    | 1.7578   | -.984       | 308.8         |  |
| 596.            | 18.0      | 19.7  | .2542        | 58.587       | 163.59     | 780.5         | 16.89      | 89.88    | 121.3          | 720.3        | 6.341       | .1443                     | .4858    | 1.7621   | -.984       | 302.3         |  |
| 597.            | 18.0      | 23.8  | .2908        | 58.695       | 170.08     | 852.3         | 16.88      | 89.04    | 132.4          | 823.2        | 7.179       | .1512                     | .4082    | 1.7587   | -.983       | 315.3         |  |
| 598.            | 18.0      | 24.2  | .2933        | 58.720       | 171.31     | 852.3         | 16.88      | 88.89    | 132.4          | 830.0        | 7.227       | .1525                     | .4083    | 1.7580   | -.983       | 316.3         |  |
| 599.            | 18.0      | 25.1  | .2978        | 58.834       | 173.77     | 852.3         | 16.88      | 88.63    | 132.2          | 842.0        | 7.309       | .1548                     | .4091    | 1.7544   | -.982       | 318.3         |  |
| 600.            | 18.0      | 21.8  | .2785        | 59.025       | 164.16     | 852.5         | 16.87      | 89.25    | 132.0          | 786.2        | 6.872       | .1448                     | .4104    | 1.7487   | -.982       | 311.3         |  |
| 601.            | 18.0      | 22.6  | .2837        | 58.813       | 166.56     | 852.5         | 16.87      | 89.24    | 132.3          | 802.1        | 7.011       | .1475                     | .4088    | 1.7554   | -.984       | 312.8         |  |
| 602.            | 18.0      | 19.4  | .2595        | 58.748       | 148.93     | 852.5         | 16.87      | 87.32    | 132.3          | 734.1        | 6.279       | .1349                     | .4084    | 1.7571   | -.983       | 304.3         |  |
| 603.            | 18.0      | 20.3  | .2664        | 58.736       | 154.45     | 852.5         | 16.87      | 88.21    | 132.4          | 753.9        | 6.514       | .1385                     | .4083    | 1.7573   | -.982       | 306.5         |  |
| 604.            | 18.0      | 21.3  | .2744        | 58.743       | 159.99     | 852.5         | 16.87      | 88.71    | 132.4          | 776.4        | 6.746       | .1426                     | .4083    | 1.7569   | -.980       | 309.2         |  |
| 605.            | 18.0      | 21.3  | .2870        | 58.965       | 144.70     | 948.8         | 16.86      | 85.05    | 147.0          | 810.6        | 6.752       | .1341                     | .3309    | 1.7502   | -.980       | 314.3         |  |
| 606.            | 18.0      | 22.7  | .2978        | 59.043       | 152.60     | 948.8         | 16.86      | 86.33    | 146.9          | 840.5        | 7.107       | .1391                     | .3313    | 1.7479   | -.980       | 318.6         |  |
| 607.            | 18.0      | 23.3  | .3016        | 59.085       | 155.22     | 948.7         | 16.86      | 86.63    | 146.9          | 851.0        | 7.221       | .1409                     | .3317    | 1.7464   | -.978       | 320.3         |  |
| 608.            | 18.0      | 24.0  | .3072        | 59.057       | 158.48     | 948.9         | 16.86      | 86.91    | 146.9          | 866.9        | 7.379       | .1435                     | .3314    | 1.7472   | -.978       | 322.3         |  |
| 609.            | 18.0      | 24.7  | .3117        | 58.987       | 161.62     | 948.8         | 16.86      | 87.45    | 147.0          | 880.0        | 7.538       | .1456                     | .3310    | 1.7497   | -.981       | 324.3         |  |
| 610.            | 18.0      | 25.7  | .3174        | 59.013       | 164.44     | 948.8         | 16.86      | 87.33    | 147.0          | 896.1        | 7.665       | .1483                     | .3311    | 1.7491   | -.982       | 326.6         |  |
| 611.            | 18.0      | 26.5  | .3221        | 59.121       | 165.69     | 948.8         | 16.86      | 86.54    | 146.8          | 908.6        | 7.702       | .1505                     | .3318    | 1.7458   | -.981       | 328.7         |  |
| 612.            | 18.0      | 27.3  | .3263        | 59.045       | 166.05     | 948.8         | 16.86      | 85.75    | 146.9          | 920.8        | 7.734       | .1524                     | .3313    | 1.7480   | -.981       | 330.3         |  |
| 613.            | 18.0      | 20.4  | .2565        | 59.251       | 175.83     | 740.5         | 16.85      | 89.84    | 114.5          | 722.5        | 6.358       | .1535                     | .5459    | 1.7410   | -.985       | 304.2         |  |
| 614.            | 18.0      | 20.4  | .2589        | 59.467       | 173.59     | 760.7         | 16.85      | 89.92    | 117.4          | 728.2        | 6.413       | .1508                     | .5191    | 1.7362   | -.984       | 305.3         |  |
| 615.            | 18.0      | 20.4  | .2606        | 59.150       | 169.46     | 780.5         | 16.85      | 89.95    | 120.8          | 734.9        | 6.475       | .1480                     | .4905    | 1.7453   | -.983       | 305.3         |  |
| 616.            | 18.0      | 20.4  | .2629        | 59.221       | 166.91     | 800.5         | 16.85      | 89.96    | 123.8          | 741.0        | 6.529       | .1456                     | .4669    | 1.7433   | -.984       | 306.2         |  |
| 617.            | 18.0      | 20.4  | .2647        | 58.961       | 162.11     | 820.5         | 16.85      | 89.35    | 127.1          | 747.6        | 6.542       | .1430                     | .4425    | 1.7506   | -.981       | 306.3         |  |
| 618.            | 18.0      | 20.4  | .2662        | 58.772       | 157.52     | 840.5         | 16.85      | 88.71    | 130.5          | 753.2        | 6.544       | .1404                     | .4203    | 1.7562   | -.981       | 306.6         |  |
| 619.            | 18.0      | 20.4  | .2691        | 58.687       | 154.08     | 860.8         | 16.85      | 88.05    | 133.7          | 761.8        | 6.570       | .1385                     | .4001    | 1.7572   | -.982       | 307.3         |  |
| 620.            | 18.0      | 20.4  | .2523        | 59.431       | 182.75     | 700.6         | 16.84      | 89.53    | 108.1          | 709.6        | 6.223       | .1596                     | .6118    | 1.7352   | -.982       | 303.3         |  |
| 621.            | 18.0      | 21.8  | .2669        | 59.094       | 177.62     | 760.5         | 16.84      | 89.80    | 117.7          | 752.9        | 6.622       | .1555                     | .5163    | 1.7453   | -.983       | 307.3         |  |
| 622.            | 18.0      | 21.8  | .2691        | 58.707       | 173.30     | 780.7         | 16.84      | 89.79    | 121.3          | 761.7        | 6.699       | .1528                     | .4866    | 1.7570   | -.985       | 307.3         |  |
| 623.            | 18.0      | 21.8  | .2719        | 58.731       | 170.53     | 800.7         | 16.84      | 89.66    | 124.3          | 769.4        | 6.757       | .1505                     | .4627    | 1.7561   | -.983       | 308.2         |  |
| 624.            | 18.0      | 21.8  | .2740        | 58.744       | 167.75     | 820.6         | 16.84      | 89.66    | 127.4          | 775.3        | 6.809       | .1480                     | .4407    | 1.7559   | -.984       | 309.2         |  |
| 625.            | 18.0      | 21.8  | .2769        | 58.796       | 165.37     | 840.6         | 16.84      | 89.51    | 130.5          | 783.2        | 6.867       | .1460                     | .4204    | 1.7542   | -.984       | 310.3         |  |
| 626.            | 18.0      | 21.8  | .2797        | 58.856       | 162.19     | 860.5         | 16.84      | 88.87    | 133.5          | 790.8        | 6.883       | .1441                     | .4016    | 1.7520   | -.981       | 311.3         |  |
| 627.            | 18.0      | 21.8  | .2820        | 58.888       | 158.79     | 880.5         | 16.83      | 88.25    | 136.5          | 797.0        | 6.890       | .1420                     | .3838    | 1.7509   | -.980       | 312.3         |  |

| GABRIEL TERRA |  | U.T.E. |  | GEC ALSTHOM NEYRPIC |  | IMHEF |  | INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES |  | Ecole Polytechnique Fédérale de Lausanne |  |
|---------------|--|--------|--|---------------------|--|-------|--|--|--|--|--|
|---------------|--|--------|--|---------------------|--|-------|--|--|--|--|--|

pour EDF *[Signature]* *[Signature]* *[Signature]*  
 100017 *[Signature]* *[Signature]*

| 328-01<br>Nº 35 |                   | Ensayo : Rendement<br>Essai: Runner : 5-KN-35 |                     |              |            |               |            |               |                |              |             | Fecha: 03 Avr 92<br>Date: |               |                 |             |               |
|-----------------|-------------------|---|---------------------|--------------|------------|---------------|------------|---------------|----------------|--------------|-------------|---------------------------|---------------|-----------------|-------------|---------------|
| No              | $\alpha_p$<br>(°) | $\gamma_d$<br>(mm)                            | $\dot{V}$<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | $\eta$<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | $\varphi$<br>(-)          | $\psi$<br>(-) | $\sigma$<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 628.            | 18.0              | 21.8  | .2849               | 58.883       | 155.66     | 900.8         | 16.83      | 87.61         | 139.7          | 805.3        | 6.911       | .1402                     | .3666         | 1.7509          | -.980       | 313.3         |
| 629.            | 18.0              | 21.8  | .2872               | 58.833       | 152.17     | 920.7         | 16.83      | 86.94         | 142.8          | 811.9        | 6.914       | .1382                     | .3506         | 1.7528          | -.982       | 314.3         |
| 630.            | 18.0              | 24.7  | .3046               | 59.041       | 168.05     | 900.9         | 16.83      | 88.25         | 139.5          | 859.8        | 7.432       | .1499                     | .3675         | 1.7467          | -.982       | 321.3         |
| 631.            | 18.0              | 24.7  | .2985               | 59.314       | 174.04     | 860.5         | 16.83      | 88.67         | 132.9          | 840.6        | 7.301       | .1537                     | .4047         | 1.7386          | -.982       | 319.3         |
| 632.            | 18.0              | 24.7  | .3008               | 59.162       | 171.17     | 880.5         | 16.83      | 88.79         | 136.2          | 848.1        | 7.376       | .1514                     | .3855         | 1.7432          | -.983       | 320.3         |
| 633.            | 18.0              | 24.7  | .3074               | 58.902       | 165.43     | 920.7         | 16.83      | 88.20         | 142.8          | 868.6        | 7.504       | .1480                     | .3510         | 1.7507          | -.981       | 322.3         |
| 634.            | 18.0              | 24.7  | .3108               | 59.178       | 164.04     | 940.6         | 16.83      | 87.94         | 145.5          | 876.2        | 7.547       | .1465                     | .3380         | 1.7428          | -.983       | 324.3         |
| 635.            | 18.0              | 24.7  | .3134               | 58.694       | 158.27     | 960.5         | 16.83      | 86.64         | 149.2          | 887.2        | 7.529       | .1446                     | .3214         | 1.7565          | -.979       | 324.3         |
| 636.            | 18.0              | 24.7  | .3157               | 58.613       | 154.07     | 980.4         | 16.83      | 85.58         | 152.4          | 894.3        | 7.497       | .1427                     | .3081         | 1.7586          | -.977       | 325.3         |
| 637.            | 18.0              | 24.7  | .3189               | 58.470       | 149.26     | 1000.9        | 16.83      | 84.01         | 155.8          | 904.4        | 7.442       | .1412                     | .2948         | 1.7630          | -.978       | 326.3         |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |
|                 |                   |   |                     |              |            |               |            |               |                |              |             |                           |               |                 |             |               |



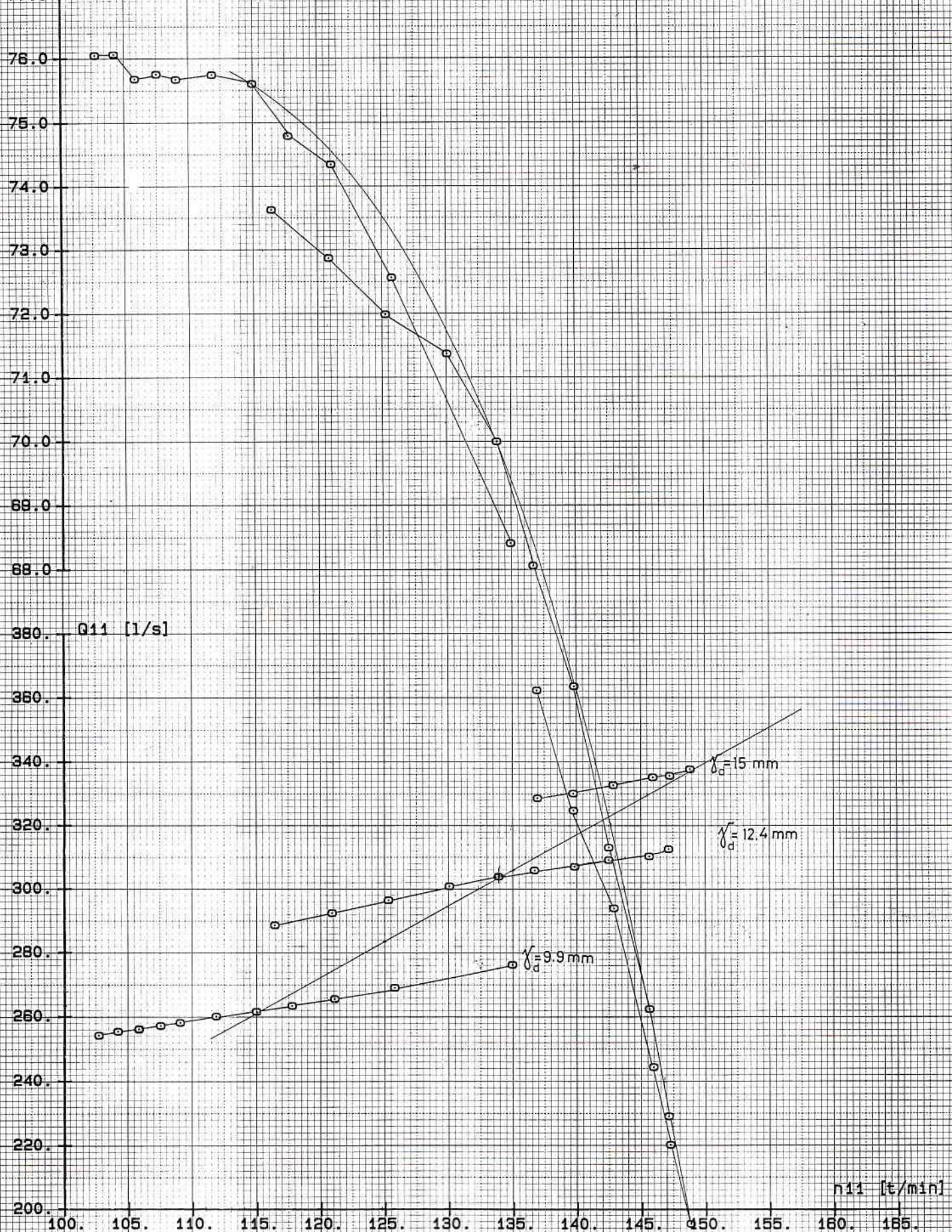
Rendimiento

Eta, Q11 = f(n11)

02 AVR 92

Eta [%] Rodete: 5-KN-35

Alpha-p = 6.0 deg. (0.6/12 tours)





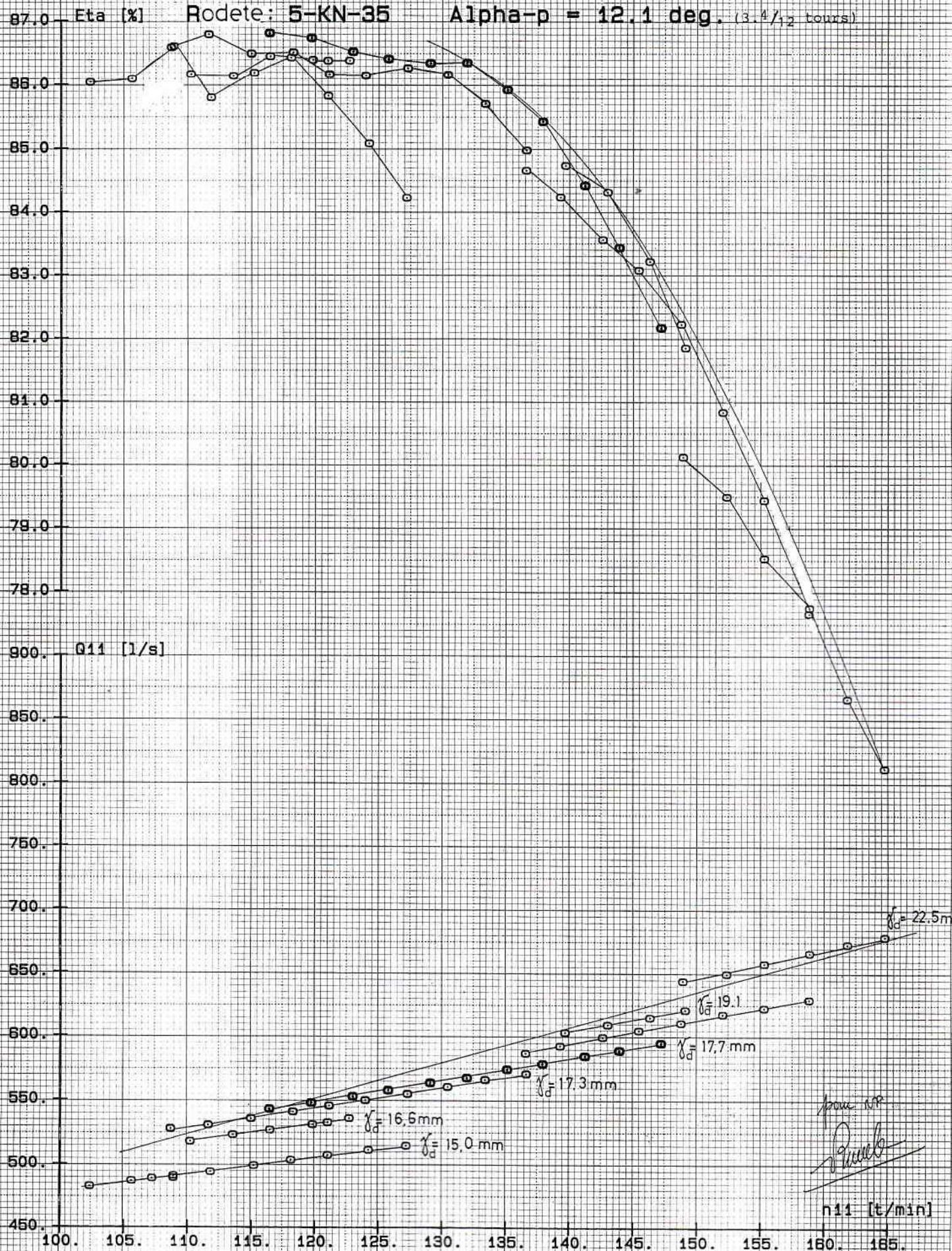
Rendimiento:

Eta,  $Q_{11} = f(n_{11})$

03 AVR 92

Rodete: 5-KN-35

Alpha-p = 12.1 deg. (3.4/12 tours)



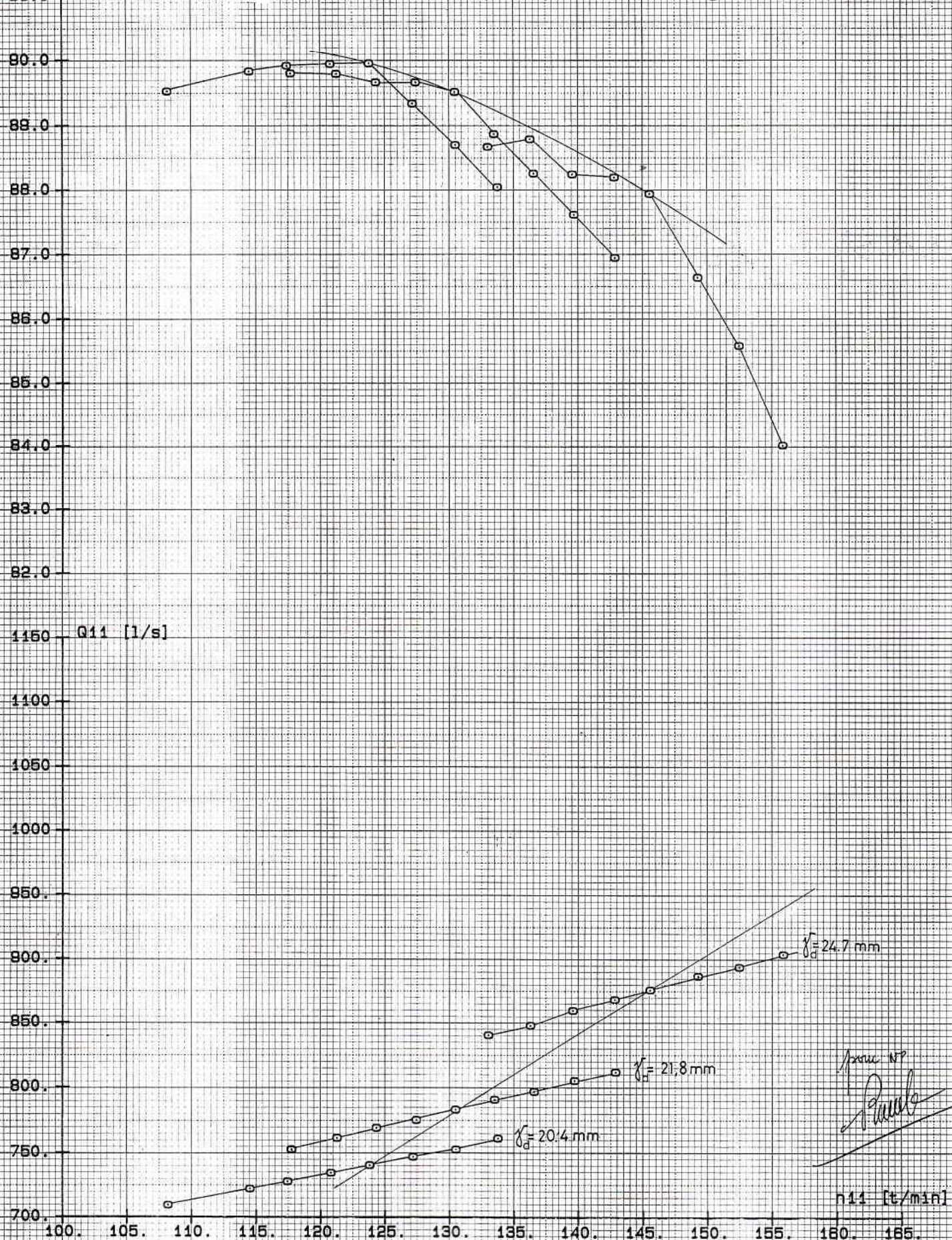


Rendimiento

Eta, Q11 = f(n11)

03 AVR 92

Eta [%] Rodete: 5-KN-35 Alpha-p = 18.0 deg. (5.10/12 tours)





328-01-36 GABRIEL TERRA

U.T.E.

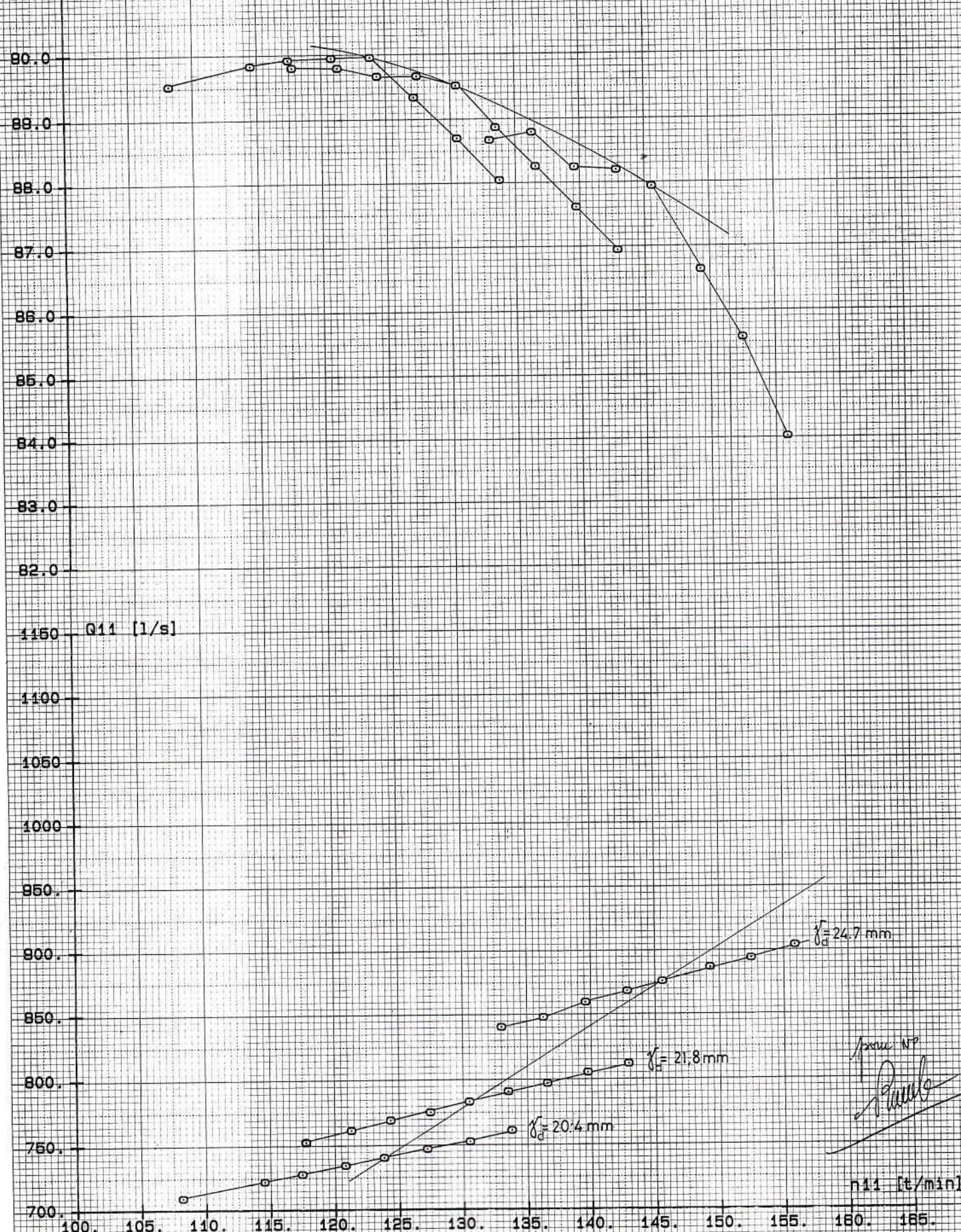
EPFL/IMHEF

Rendimiento

Eta, Q11 = f(n11)

03 AVR 92

Eta [%] Rodete: 5-KN-35 Alpha-p = 18.0 deg. (5.10/12 tours)





328-01-19 GABRIEL TERRA

U.T.E.

EPFL/IMHEF

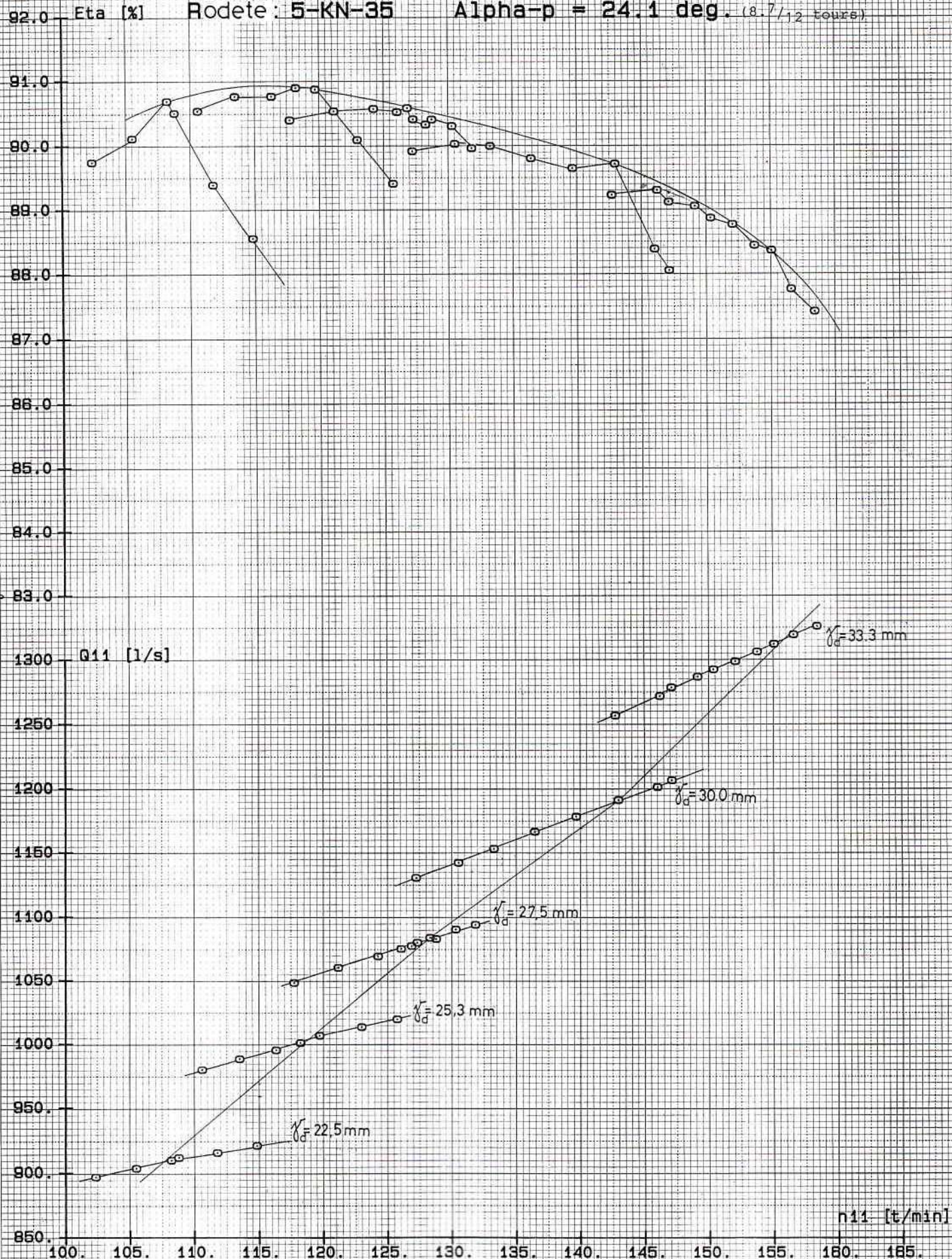
Rendimiento

Eta,  $Q_{11} = f(n_{11})$

01 AVR 92

Rodete: 5-KN-35

Alpha-p = 24.1 deg. (8.7/12 tours)





328-01-17 GABRIEL TERRA

U.T.E.

EPFL/IMHEF

Rendimiento

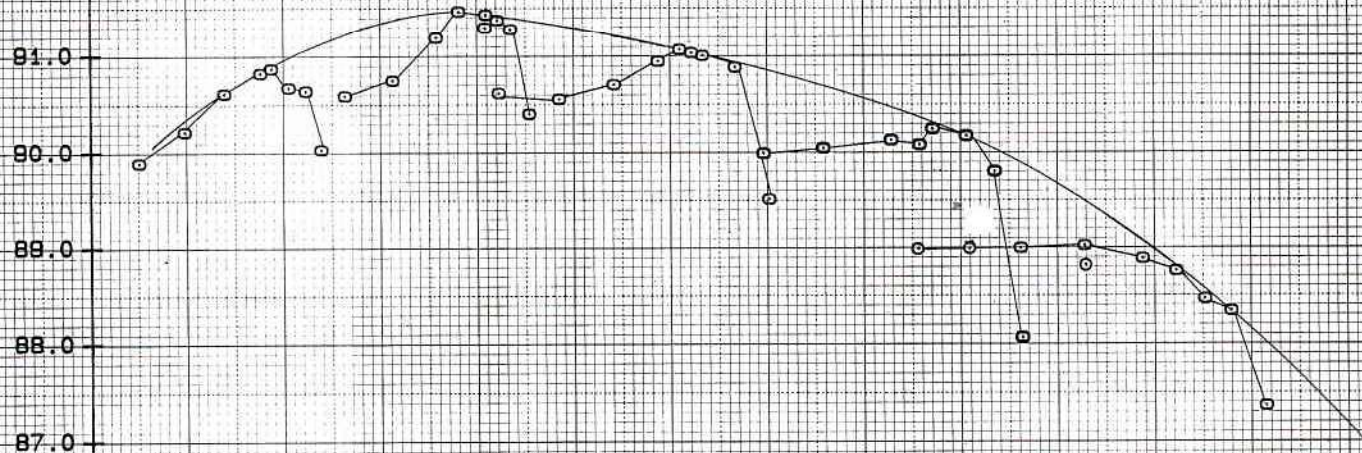
Eta, Q11 = f(n11)

01 AVR 92

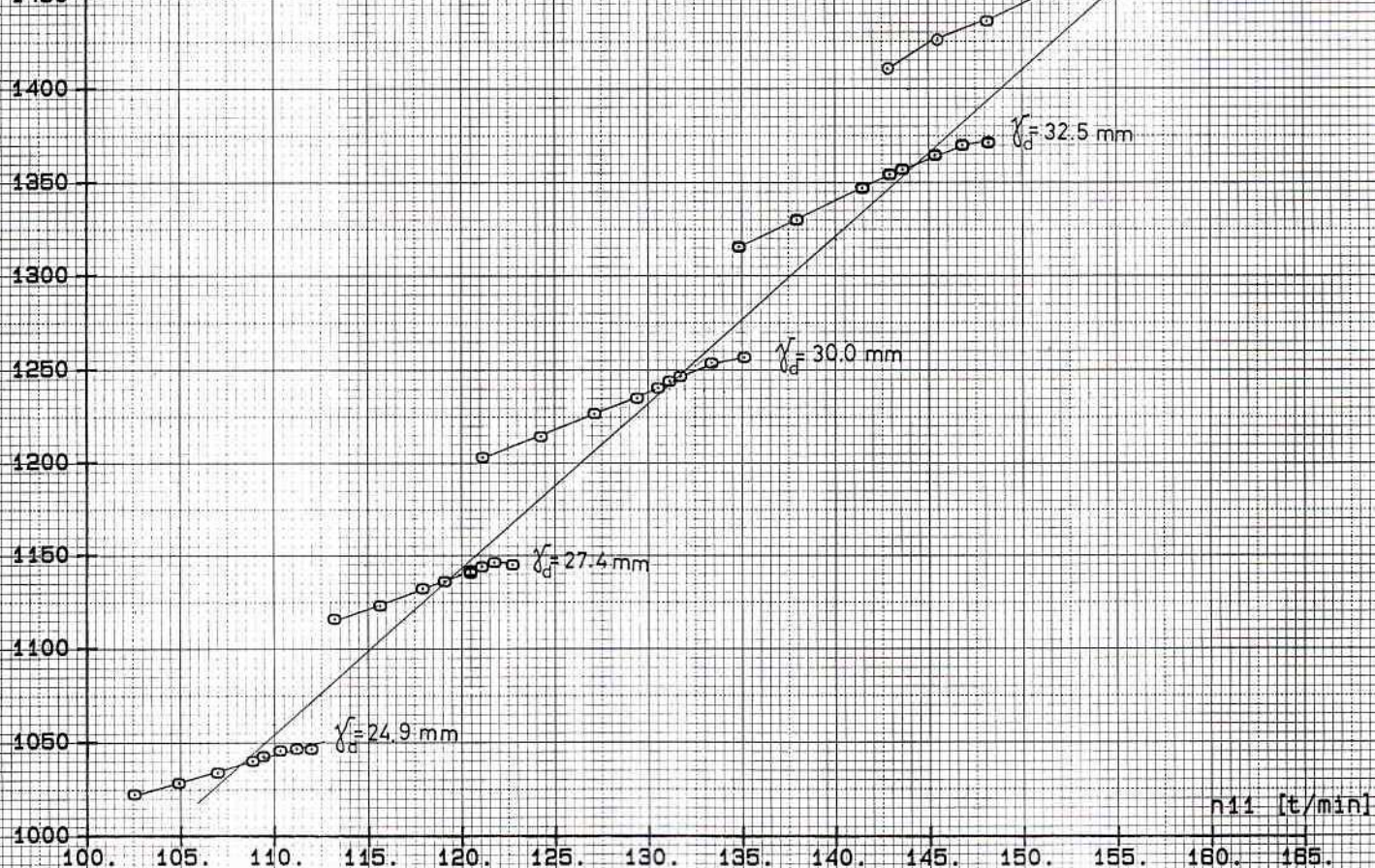
Eta [%]

Rodete: 5-KN-35

Alpha-p = 27 deg. (9.9/12 tours)



Q11 [l/s]



pour cas  
pour UTE  
pour n11  
pour IMHEF  
pour n11



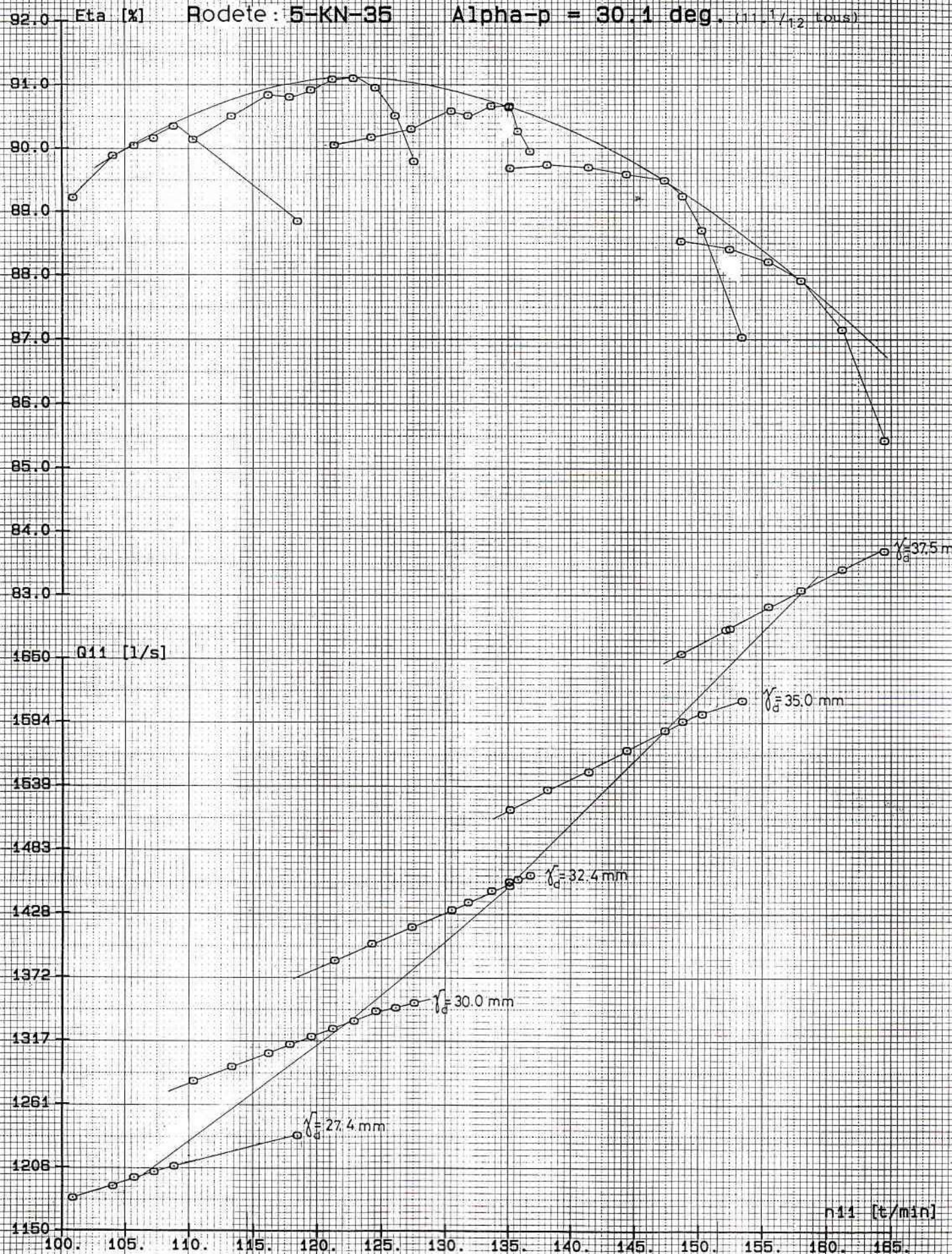
Rendimiento

Eta, Q11 = f(n11)

02 AVR 92

Rodete: 5-KN-35

Alpha-p = 30.1 deg. (11.1/12 tous)





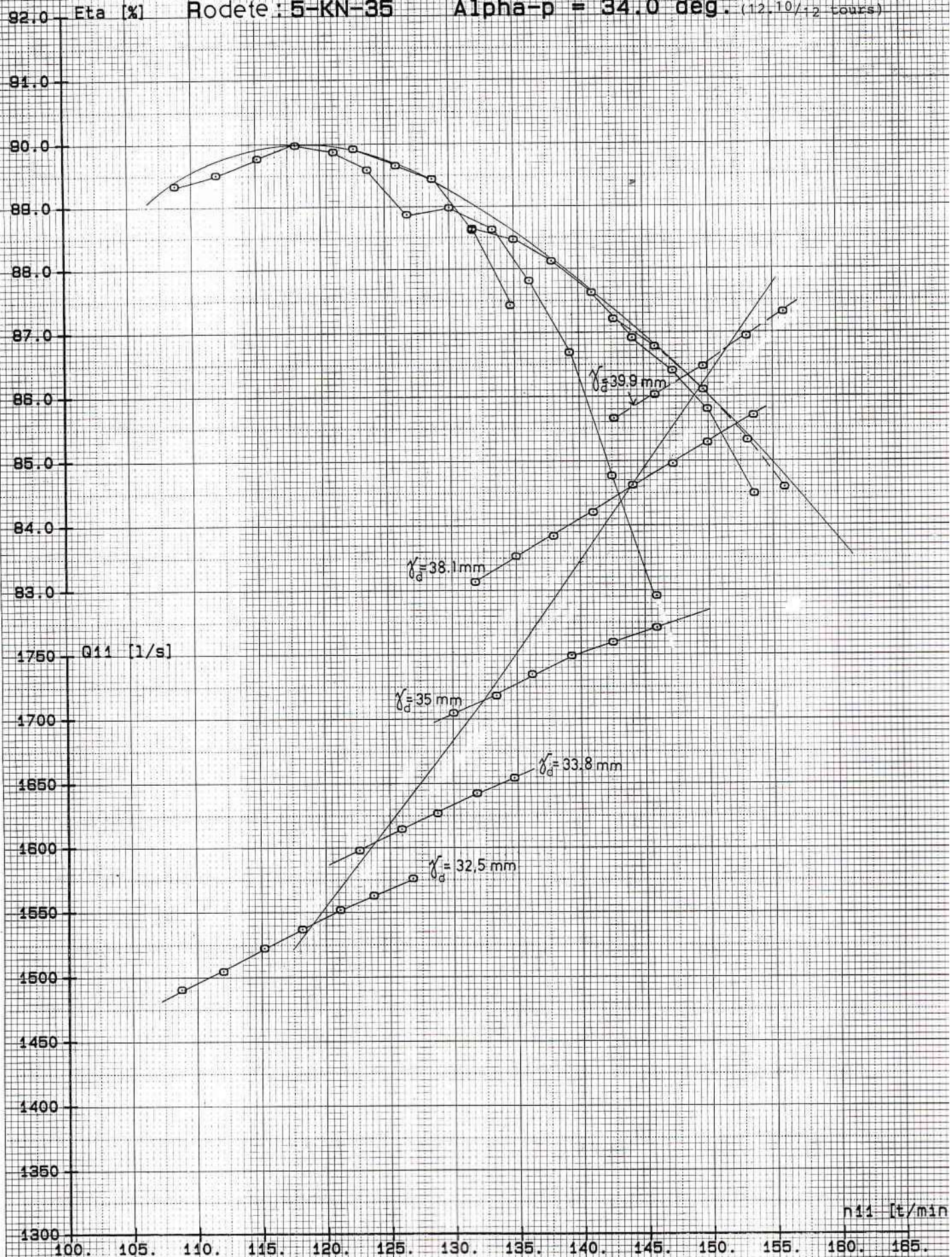
Rendimiento

Eta, Q11 = f(n11)

02 AVR 92

Rodete : 5-KN-35

Alpha-p = 34.0 deg. (12.10/12 tours)





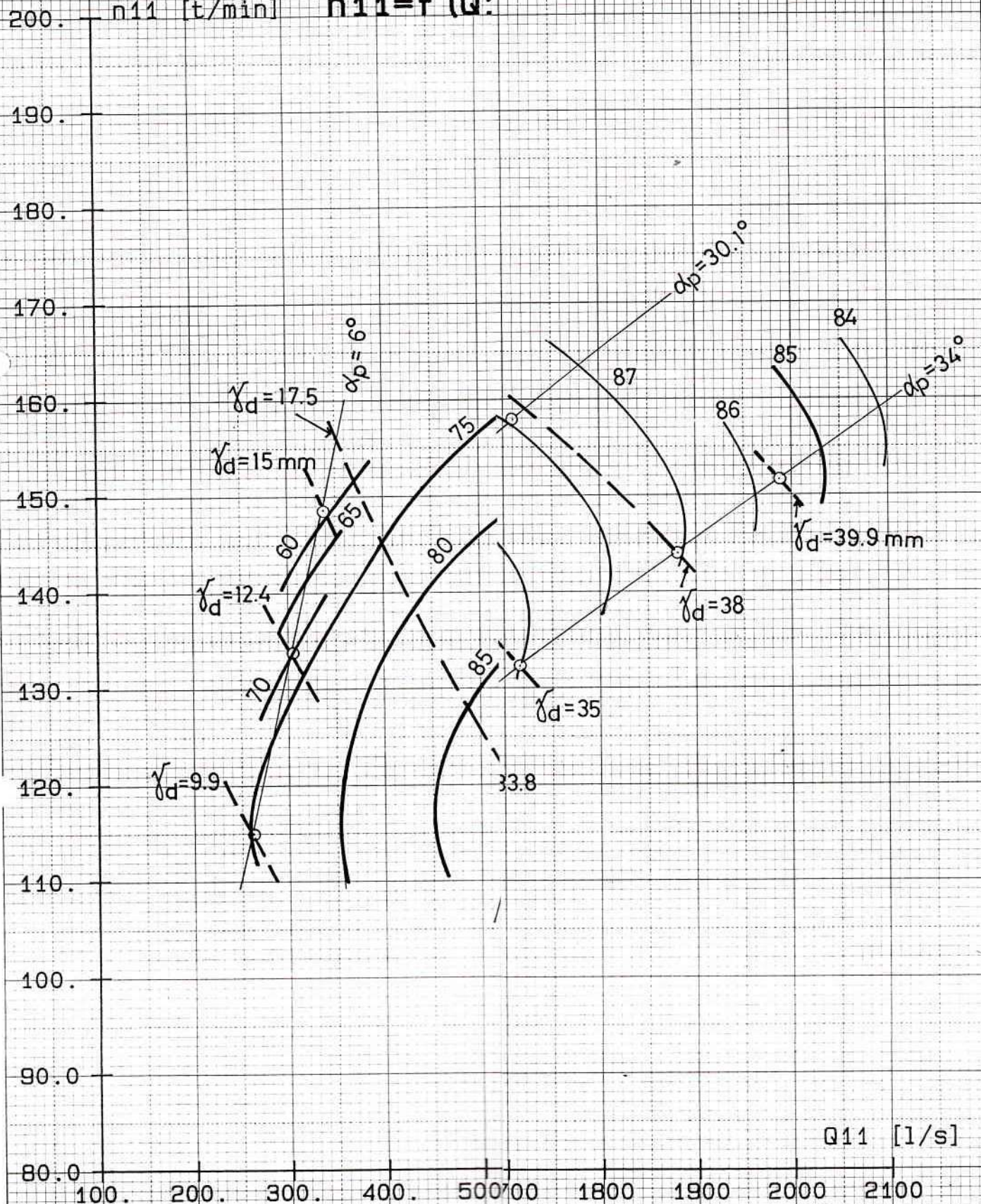
328-01-38 GABR

Caracter

EPFL/IMHEF

06 ABR 92

n11 [t/min] n11=f(Q11)

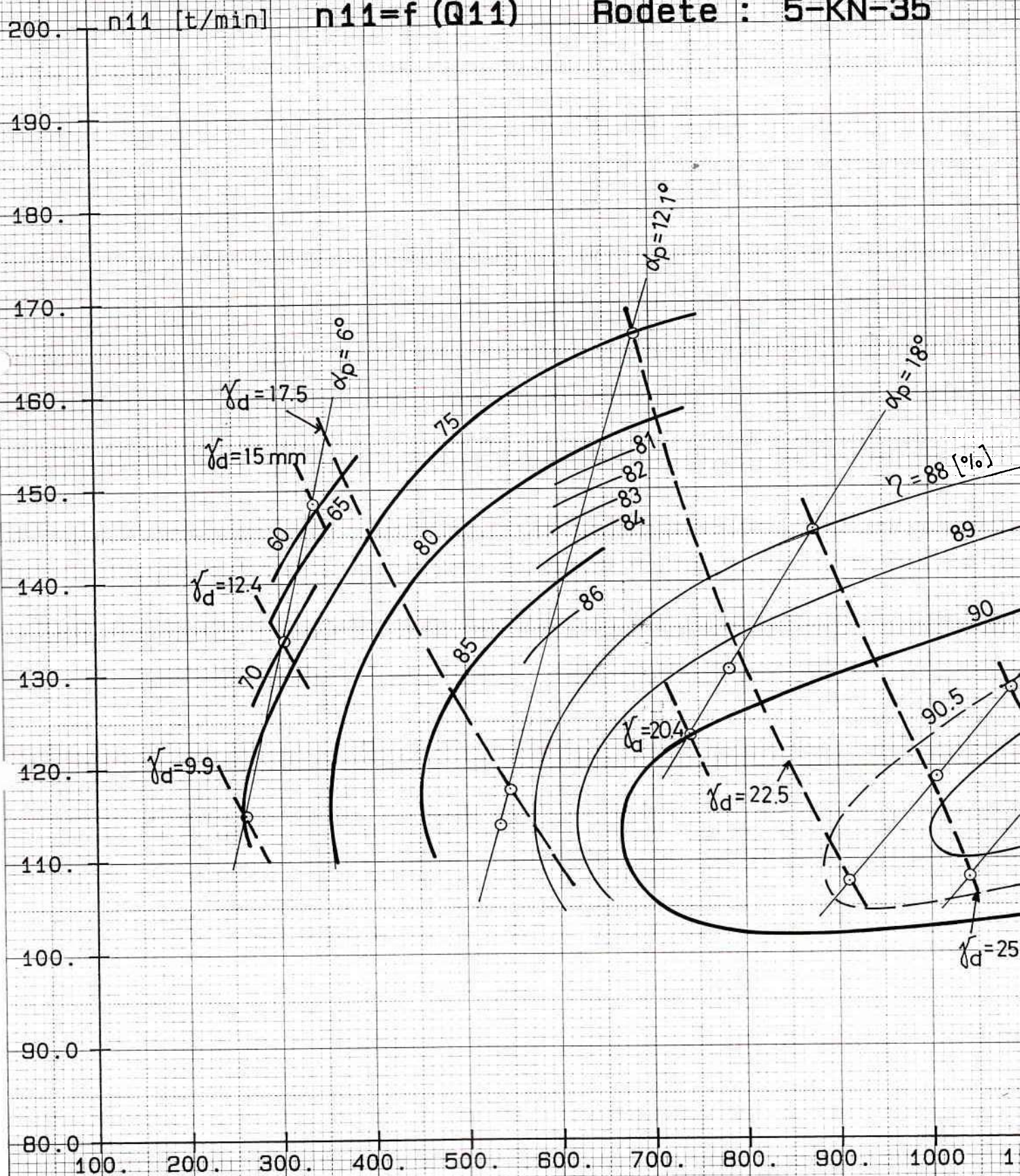




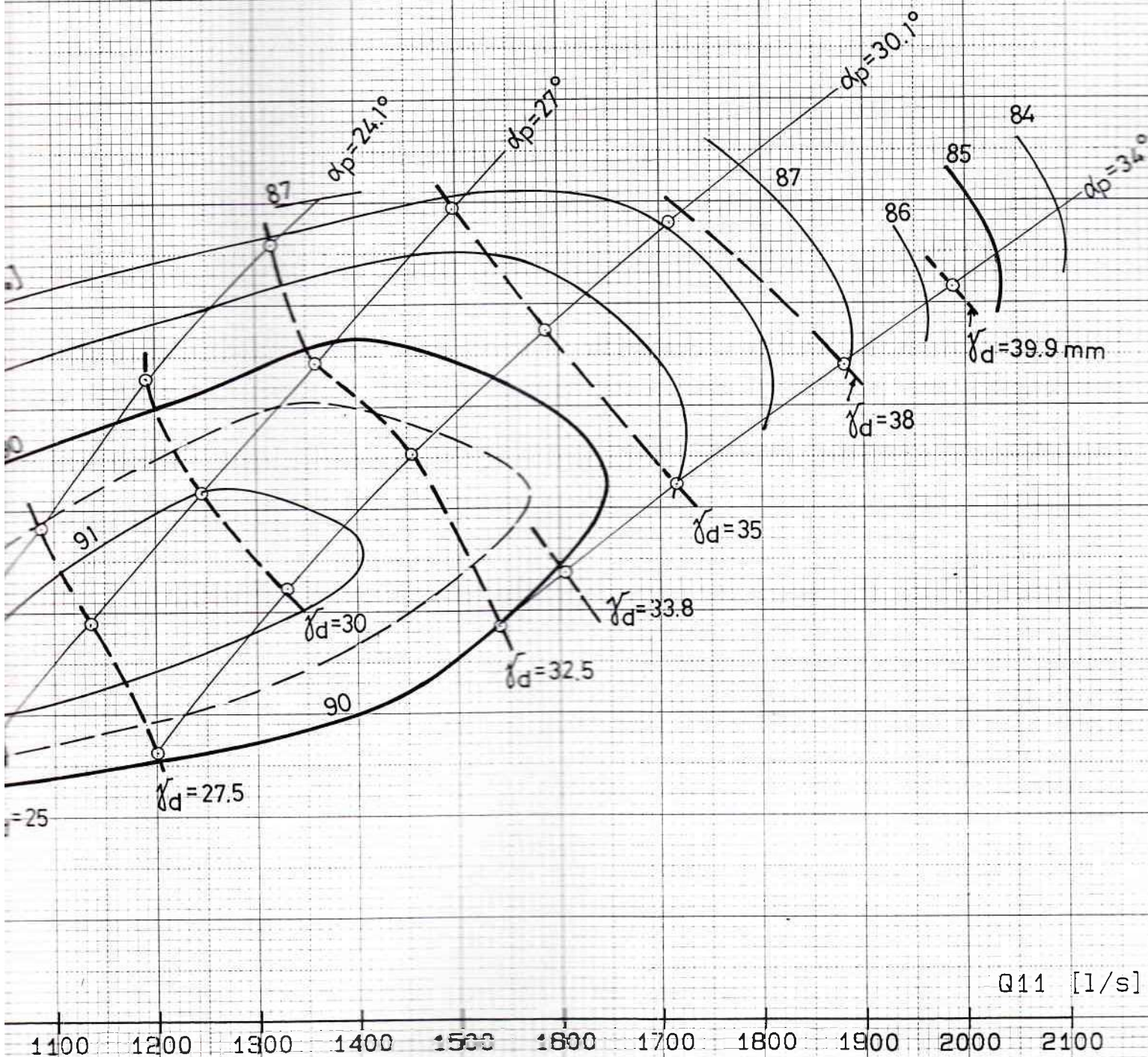
## Característica de rendimiento

 $n_{11} = f(Q_{11})$ 

Rodete : 5-KN-35







$Q_{11}$  [l/s]

U.T.E. GABRIEL TERRA

AR 1

Essais de rendement à EPFL les 01-02-03/04/92  
Transposition par Hutton

$$\Delta\eta = \eta_p - \eta_m = 0,7 (1 - \eta_m) \left[ 1 - \left( \frac{D_m}{D_p} \frac{v_p}{v_m} \left( \frac{H_m}{H_p} \right)^{1/2} \right)^{1/5} \right]$$

$$P = \eta_p \cdot \rho_p \cdot g_p \cdot Q_p \cdot H_p$$

Données du modèle

température de l'eau ≠ 16,5°C

$$v_m = 1,0933 \cdot 10^{-5} \text{ m}^2/\text{s}$$

$H_m \neq 6 \text{ mCE}$

$$D_m = 0,380 \text{ m}$$

Données du prototype

température de l'eau ≠ 20°C

$$v_p = 1,004 \cdot 10^{-6} \text{ m}^2/\text{s}$$

$$H_p = 17 - 21 - 25 \text{ mCE}$$

$$D_p = 4,848 \text{ m}$$

$$\rho_p = 998,2 \text{ kg/m}^3$$

$$g_p = 9,7947 \text{ m/s}^2$$

$$\text{latitude} = 32^\circ$$

$$\text{altitude} = 50,5 \text{ m}$$

$\Delta\eta$  est limité à 5%.

pour IMHEF  
Hutton  
pour EPFL  
R. Hutton

pour NP  
R. Hutton

pour IMHEF  
Hutton  
pour EPFL  
R. Hutton

U. T. E. GABRIEL TERRA AR2

Résultats de rendement à EPFL

 $H_m = 17 \text{ mCE}$ 

|          |        |        |        |        |        |        |
|----------|--------|--------|--------|--------|--------|--------|
| $\eta_m$ | 83.3   | 87,45  | 89.25  | 89,5   | 89.65  | 86,8   |
| $Q_{11}$ | 620    | 880    | 1230   | 1383   | 1580   | 1970.  |
| $Q_p$    | 60,08  | 85,28  | 119,19 | 134,02 | 153,11 | 190,9  |
| $P$      | 8,864  | 12,977 | 18,378 | 20,702 | 23,677 | 28,912 |
| $\eta_p$ | 88,77. | 91,56  | 92,77  | 92,94  | 93,04  | 91,12  |

 $H_m = 21 \text{ mCE}$ 

|          |       |        |        |        |        |        |        |
|----------|-------|--------|--------|--------|--------|--------|--------|
| $\eta_m$ | 69.1  | 86.3   | 89.2   | 90.3   | 90,65  | 90,8   | 88,7   |
| $Q_{11}$ | 262   | 565    | 785    | 1112   | 1252   | 1427   | 1800   |
| $Q_p$    | 28,22 | 60,85  | 84,55  | 119,77 | 134,85 | 153,69 | 193,87 |
| $P$      | 4,604 | 11,356 | 16,113 | 23,005 | 25,965 | 29,626 | 36,814 |
| $\eta_p$ | 75,65 | 90,89  | 92,82  | 93,55  | 93,78  | 93,88  | 92,69  |

 $H_m = 25 \text{ mCE}$ 

|          |       |        |        |        |        |        |        |
|----------|-------|--------|--------|--------|--------|--------|--------|
| $\eta_m$ | 73.3  | 86,6   | 90.2   | 90,9   | 91,2   | 91,2   | 89,7   |
| $Q_{11}$ | 252   | 520    | 730    | 1025   | 1155   | 1320   | 1600   |
| $Q_p$    | 29,62 | 61,11  | 85,79  | 120,45 | 135,73 | 155,12 | 188,02 |
| $P$      | 5,966 | 13,618 | 19,615 | 27,678 | 31,253 | 35,718 | 42,84  |
| $\eta_p$ | 82,42 | 91,18  | 93,55  | 94,01  | 94,20  | 94,20  | 93,22. |

pour NP  
*[Signature]*  
*[Signature]*

pour JMHEF  
*[Signature]*

pour EDF  
*[Signature]*



UTE

GABRIEL

TERRA

AR3

Calcul du rendement mesuré pondéré

| chute<br>(m) | Puissance |       | Pondération | Rendement $\eta$ (%) |        |
|--------------|-----------|-------|-------------|----------------------|--------|
|              | % Pmax    | MW    |             | Garanti              | Mesuré |
| 25,0         | 95        | 36,86 | 10          | 92,7                 | 94,1   |
| 25,0         | 85        | 32,98 | 10          | 93,25                | 94,2   |
| 25,0         | 75        | 29,10 | 7           | 93,5                 | 94,1   |
| 25,0         | 65        | 25,22 | 5           | 93,45                | 93,9   |
| 25,0         | 55        | 21,34 | 4           | 93,1                 | 93,7   |
| 25,0         | 45        | 17,46 | 2           | 92,35                | 93,1   |
| 21,0         | 85        | 32,98 | 5           | 91,15                | 93,6   |
| 21,0         | 75        | 29,10 | 10          | 92,65                | 93,9   |
| 21,0         | 65        | 25,22 | 9           | 93,1                 | 93,6   |
| 21,0         | 55        | 21,34 | 8           | 93,2                 | 93,4   |
| 21,0         | 45        | 17,46 | 6           | 92,7                 | 93,0   |
| 17,0         | 65        | 25,22 | 5           | 90,25                | 92,8   |
| 17,0         | 55        | 21,34 | 10          | 92,1                 | 93,0   |
| 17,0         | 45        | 17,46 | 9           | 92,45                | 92,5   |

total 100

Rendement garanti moyen pondéré = 92,65%

Rendement mesuré (puis transposé) moyen pondéré = 93,53%

Par UTE

Informations  


pour NP



pour IMHEF



pour EDF 



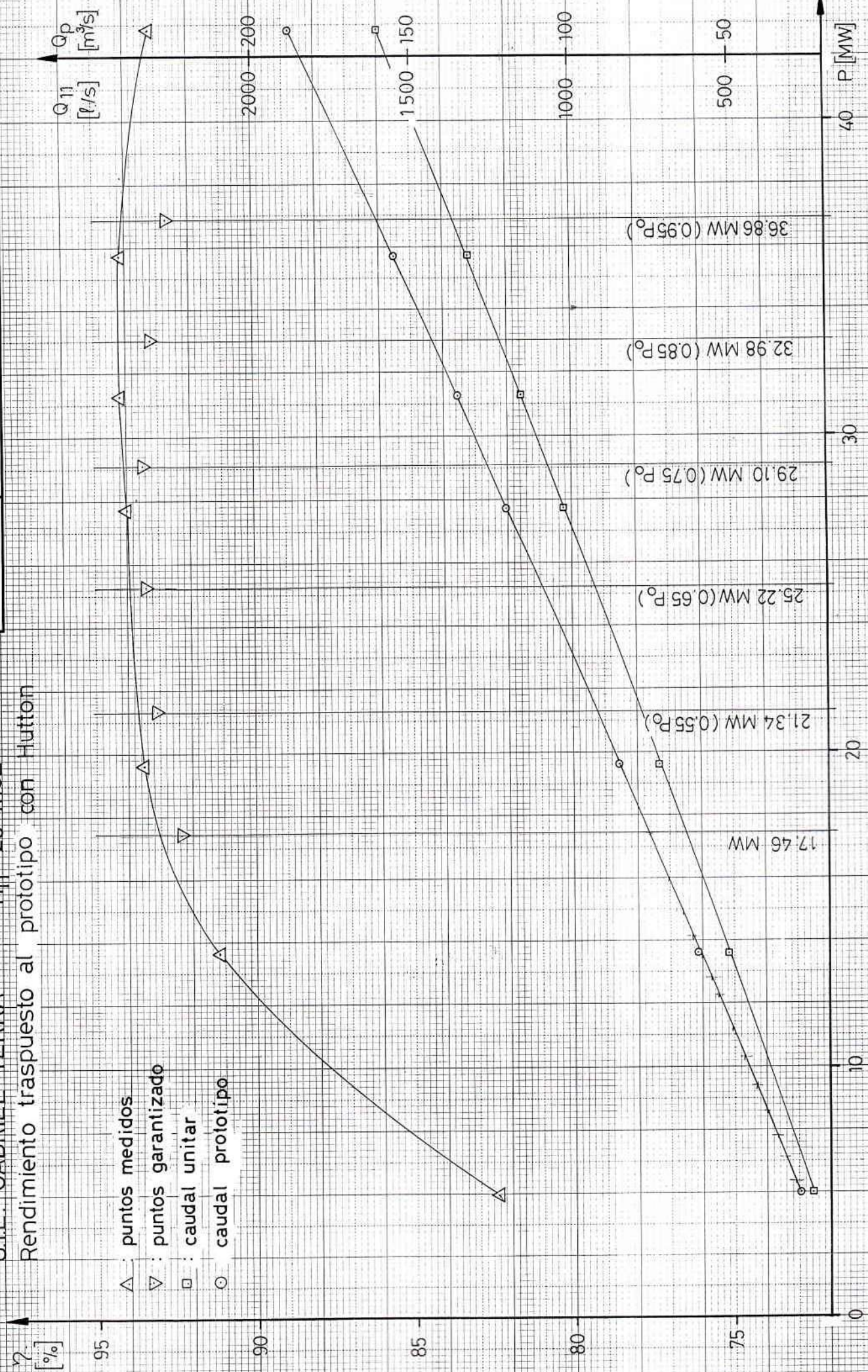


IMHEF  
INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

R1

UIE GABRIEL TERRA  $H_n = 25$  mCE

Rendimiento traspuesto al prototipo con Hutton







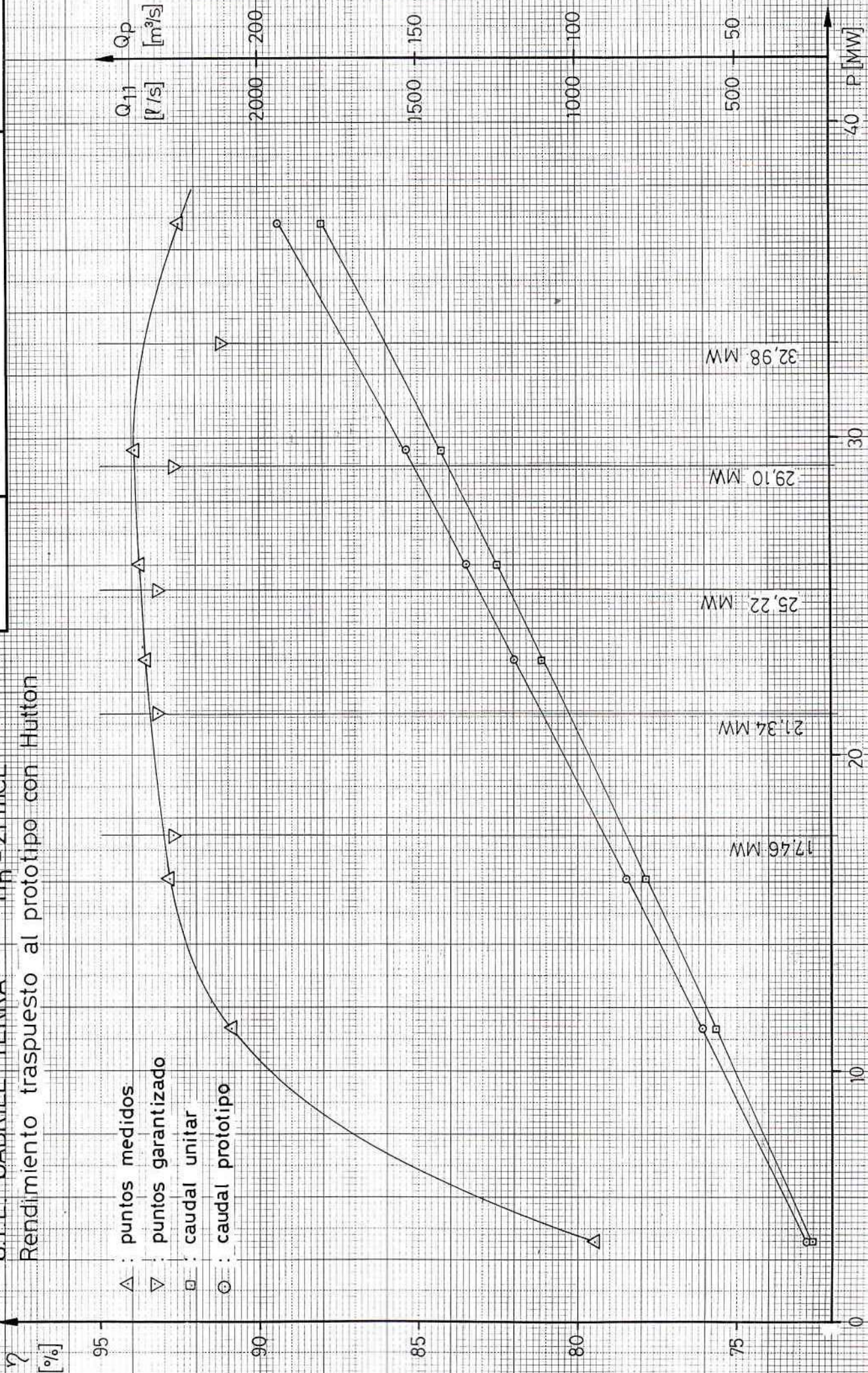
IMHHEF  
INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

R2

U.T.E. GABRIEL TERRA  $H_n = 21$  mCE

Rendimiento traspuesto al prototipo con Hutton

- $\Delta$  : puntos medidos
- $\nabla$  : puntos garantizado
- $\square$  : caudal unitar
- $\circ$  : caudal prototipo





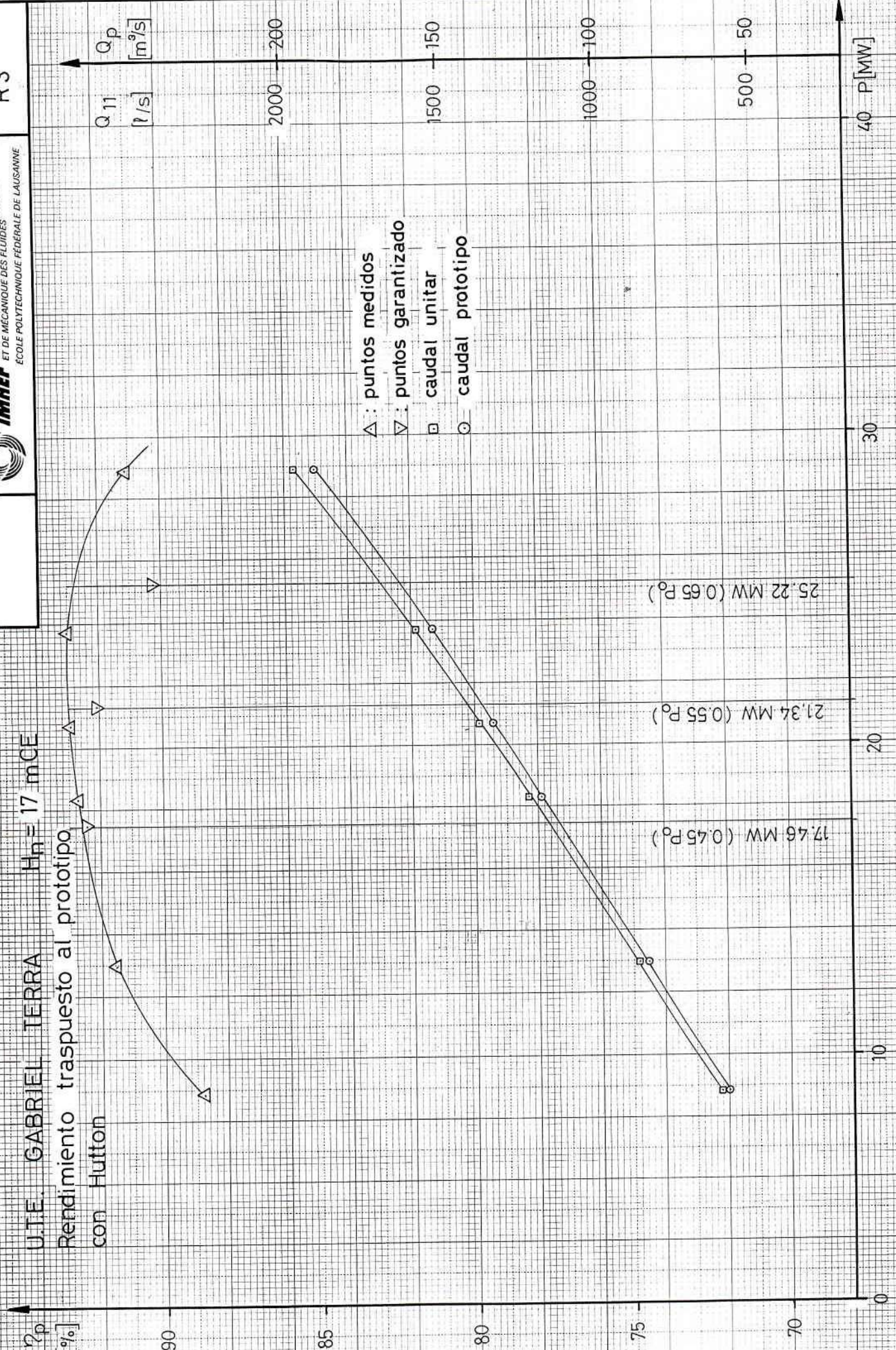


IMHEF  
INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

R3

U.T.E. GABRIEL TERRA  $H_n = 17$  mCE

Rendimiento traspuesto al prototipo  
con Hutton





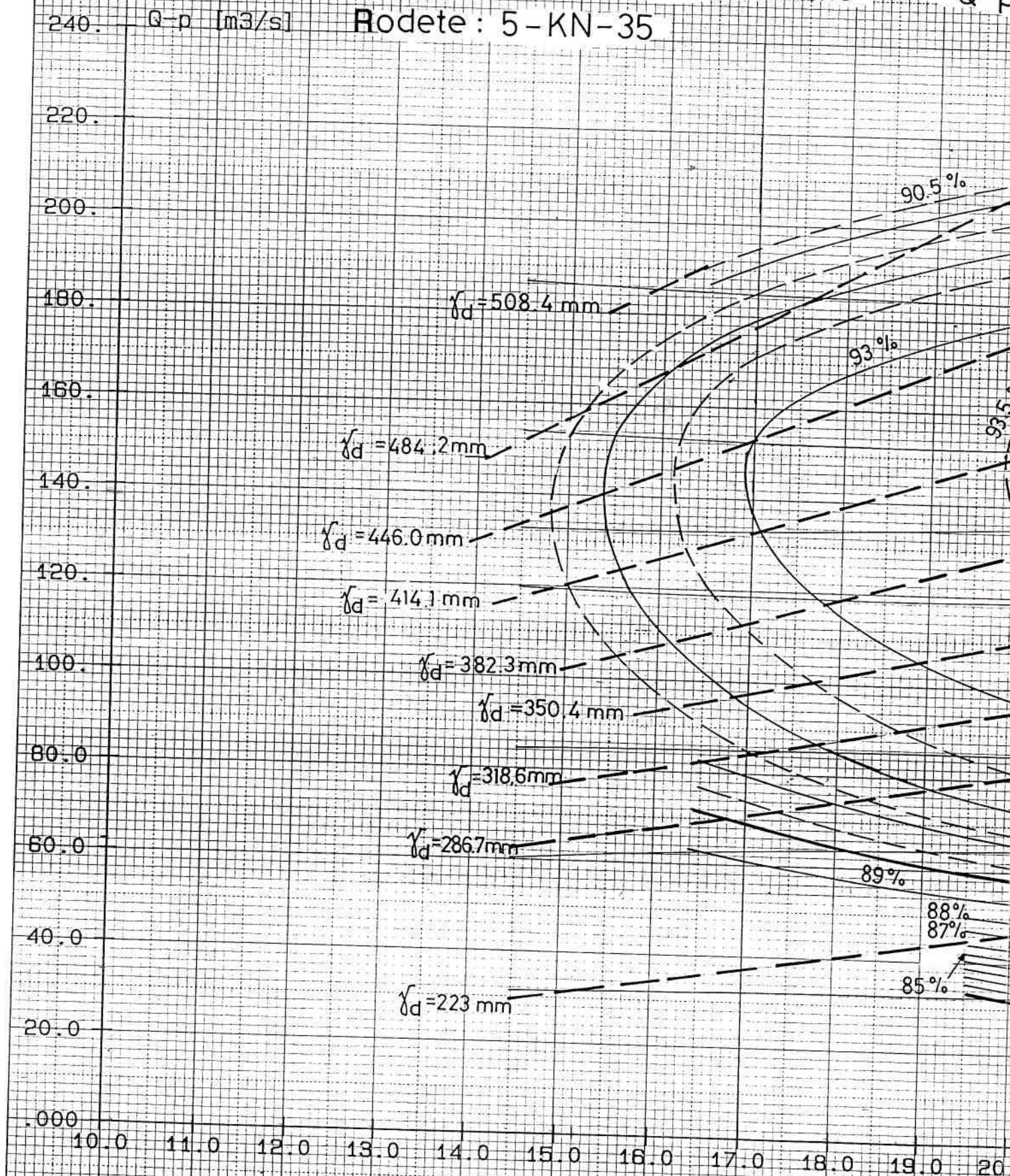
328-01-39 GABRIEL TERRA

U.

Característica de rendimiento

Q-p

Rodete: 5-KN-35



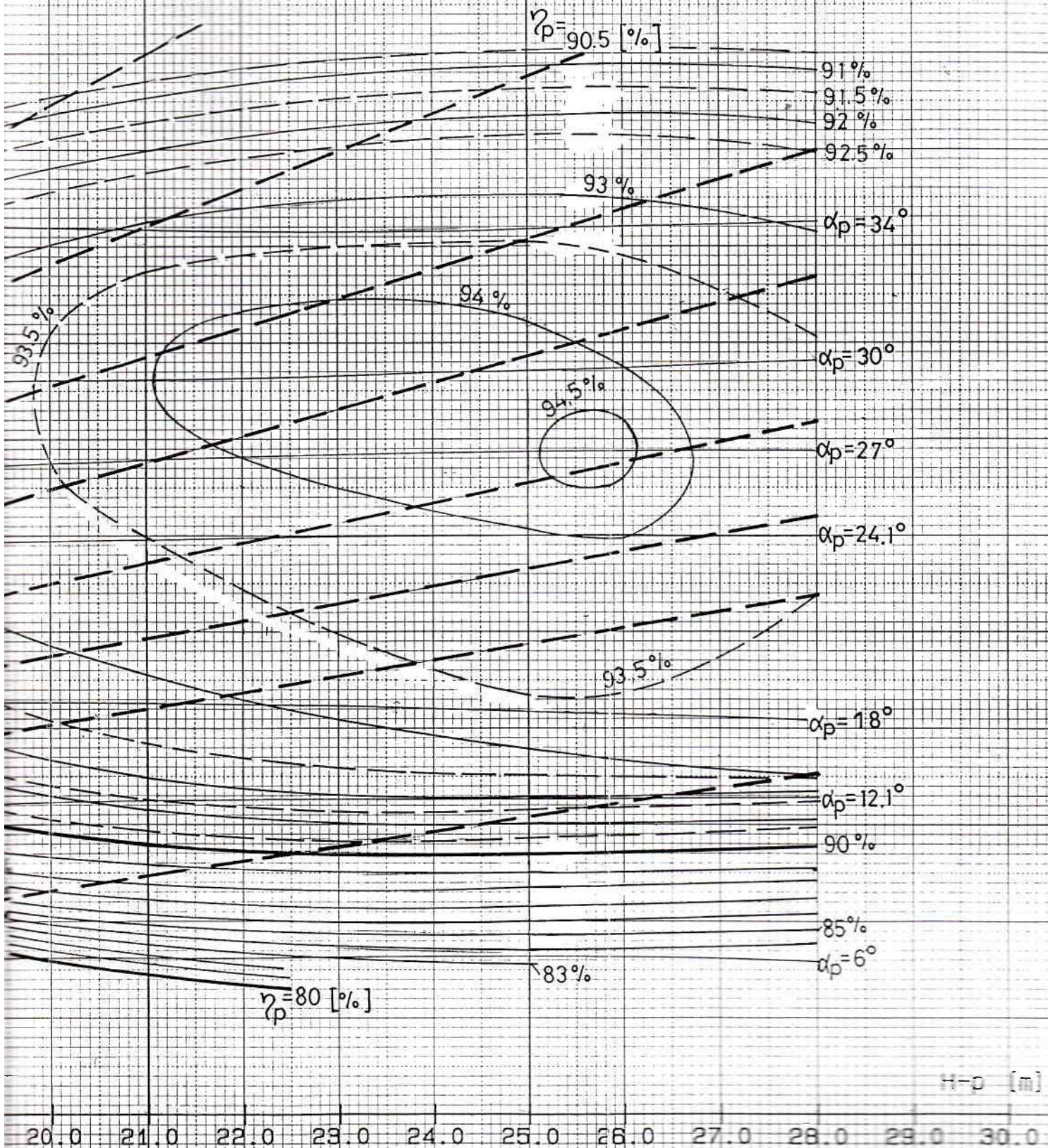


.T.E.

EPFL/IMHEF

$$p = f(H-p)$$

06 ABR 92





***328-02***

***CAVITACION***

# GABRIEL TERRA

## Essai de cavitation du 03/04/92 au 04/04/92

En accord avec les représentants de UTE et de EDF, les fonctionnements suivants ont été étudiés sur le modèle réduit à EPFL:

| $H_p$ | $Q_p$ | $n_{11}$ | $Q_{11}$ | $\sigma_s$             | $\sigma_i$ | (niveau aval) | $\sigma_i/\sigma_s$ |
|-------|-------|----------|----------|------------------------|------------|---------------|---------------------|
| 21    | 173.2 | 132.2    | 1608     | 0.455                  | 0.692      | 55            | 1.52                |
| 21    | 158.5 | 132.2    | 1472     | 0.4                    | 0.597      | 53            | 1.49                |
| 26    | 162.6 | 118.85   | 1356.6   | 0.36                   | 0.54       | 54.5          | 1.5                 |
| 16    | 165   | 151.5    | 1755     | 0.54                   | 0.864      | 54.3          | 1.6                 |
| 21    | 27.9  | 132.2    | 259.4    | $(\alpha_p = 6^\circ)$ |            |               |                     |
| 17    | 30.3  | 147      | 313      | $(\alpha_p = 6^\circ)$ |            |               |                     |

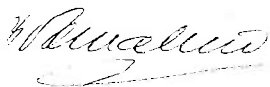
Les figures de cavitation, souvent intermittentes, se limitent principalement au contour de l'aube:

- cavitation marginale en ceinture
- cavitation au moyen prenant naissance dans le jeu pale moyen
- cavitation d'entrée extradados sous la chute maximale (sur une partie de l'arête)
- cavitation d'entrée intrados sous la chute minimale (sur une partie de l'arête).

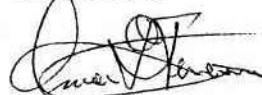
Lausanne, le 06/04/92

pour U.T.E.:

Mme Tomalino



M. Ferreño



**Commentaire.** Ces figures de cavitation acceptables et la marge confortable ( $\sigma_i/\sigma_s \approx 1.5$ ) permettent de conclure que le tracé de roue adopté pour Gabriel Terra est satisfaisant en cavitation.

pour EDF:

M. Fritsch



pour NP:

M. Vinh



pour IMHEF:

M. Mombelli





***EJEMPLO DE  
CALCULO DE UN  
PUNTO DE  
MEDIDA***

***( punto No 1 del  
ensayos de  
cavitacion )***

**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

Date:

328-02

GABRIEL TERRA

03 Avr 92

Cavitation

Roue : 5-KN-35

18:52:40

## PARAMETRES D'ESSAI

|                      |         | Pentes          | Ordonnees |        |
|----------------------|---------|-----------------|-----------|--------|
| TEMPERATURE          | gamme 1 | 9.88410         | -.04160   |        |
| DEBIT 1              | gamme 1 | .04405          | .30388    | caudal |
| (turbine)            | gamme 2 | .30119          | .02667    |        |
|                      | gamme 3 | .00000          | .00000    |        |
| DEBIT 1              | gamme 1 | .00000          | .00000    |        |
| (pompe)              | gamme 2 | .00000          | .00000    |        |
|                      | gamme 3 | .00000          | .00000    |        |
| ENERGIE              | gamme 1 | .08170          | .11930    | salto  |
| (PD1)                | gamme 2 | .00000          | .00000    |        |
| CAVITATION           | gamme 1 | .08299          | .12840    |        |
|                      | gamme 2 | .08239          | -.06490   |        |
|                      | gamme 3 | .00000          | .00000    |        |
| COUPLE 2             | gamme 1 | 24.80748        | .19442    | } par  |
|                      | gamme 2 | .00000          | .00000    |        |
| COUPLE FROT.         | Stand 2 | .91743          | .14606    |        |
| POUSSEE AX.          | gamme 1 | .00000          | .00000    |        |
| COEFFICIENT DE GAMME |         | 0 1 0 1 2 6 1 1 |           |        |

## CONSTANTES

|                        |         |          |            |          |
|------------------------|---------|----------|------------|----------|
| RAYON DE CEINTURE      | C-1e    | .19000   | R1i        | .00000   |
| SECTIONS               | Amont   | .23646   | Aval       | .60690   |
| ACC. TERRESTRE         | Univ.   | 9.80665  | Locale     | 9.80630  |
| DIAM. STATORS          | Stand 1 | 1.27985  | Stand 2    | 1.08020  |
| R CAPT. FROT.          | Stand 1 | .26585   | Stand 2    | .26465   |
| MASSE PLATEAUX         | Stand 1 | 20.18490 | Stand 2    | 20.18470 |
| MASSE ADDITION.        | [kg]    | 40.00000 | u PIEZO    | 998.58   |
| (uHg-uH2O)g            | Chute   | 123026.7 | Haut. asp. | 123044.4 |
| DIAM. REFERENCE        |         | .00000   | VIT. REF.  | .00000   |
| PRESSION ATM. CORRIGEE |         | 94700.0  |            |          |

FICHER : TERR08.DAT Dernier enregistrement : 4

 Pour UTE   
 Pour EBF 

Pour NP

Pour IMHEF



Essai:

328-02

GABRIEL TERRA

Date:

03 Avr 92

Cavitation

Roue : 5-KN-35

08:41:42

## IMPULSIONS COMPTEURS

|                            |   |         |                  |
|----------------------------|---|---------|------------------|
| Mesure No                  | : | 1.      |                  |
| Compteur TEMPERATURE       | : | 31944.  | temperatura      |
| Compteur dP SIGMA          | : | 105472. |                  |
| Compteur .....             | : | .       |                  |
| Compteur ENERGIE (chute)   | : | 119518. | salto            |
| Compteur VITESSE stand 1   | : | .       |                  |
| Compteur HORLOGE           | : | 20000.  | tiempo de medida |
| Compteur DEBIT ultrason.   | : | 1.      |                  |
| Compteur VITESSE pompe     | : | 5026.   |                  |
| Compteur VITESSE stand 2   | : | 17050.  | velocidad        |
| Compteur COUPLE principal  | : | 57334.  | } par            |
| Compteur COUPLE frottement | : | 85682.  |                  |
| Compteur DEBIT electrom.   | : | 47793.  | caudal           |

Coefficients de gamme : 0 1 0 1 2 6 1 1

Ejemplo de calculo : punto n° 1 de cavitation

$$T_e^{\circ} = 9.8841 * \left( \frac{31944}{20000} + 0.0416 \right) = 16.20^{\circ} \text{C}$$

$$\mu_e = 1000.1800014 + 0.0084284 * T_e^{\circ} - 0.0052857 * (T_e^{\circ})^2$$

$$\mu_e = 998.93 \text{ kg/m}^3$$

$$\dot{V} = 0.04405 * \left( \frac{47793}{20000} - 0.30388 \right) = 0.09188 \text{ m}^3/\text{s}$$

$$gH_c = \left( \frac{1}{(.23646)^2} - \frac{1}{(.60690)^2} \right) * \frac{\dot{V}^2}{2} = 0.064 \text{ J/kg}$$

$$gH_p = * \frac{123026.7}{\mu_e} * .0817 * \left( \frac{119518}{20000} - .1193 \right)$$

$$gH_p = 58.929 \text{ J/kg}$$





Essai:

Date:

$$gH = gH_p + gH_c = 58.993 \text{ J/Kg}$$

$$H = 6.02 \text{ mCE}$$

$$T_i = 9.8063 * 24.80748 * \left( \frac{57334}{20000} - .19442 \right) * \frac{1.0802}{2} =$$

$$T_i = 351.11 \text{ Nm}$$

$$T_{i\text{frott}} = 9.8063 * 0.91743 * \left( \frac{85682}{20000} - .14606 \right) * .26465 =$$

$$T_{i\text{frott}} = 3.85246 \text{ Nm}$$

$$T_{i\text{-add}} = 9.8063 * \left( 20.1847 + 40.0 \right) * \frac{1.0802}{2} =$$

$$T_{i\text{-add}} = 318.761 \text{ Nm}$$

$$T_{i\text{-tot}} = T_i + T_{i\text{-frott}} - T_{i\text{-add}} = 42.20 \text{ Nm}$$

$$\dot{N}_m = 1000 * \frac{17050}{20000} = 852.5 \text{ t/min}$$

$$N = 89.27 \text{ s}^{-1}$$

$$\dot{E} = \frac{\mu_e * \dot{V} * gH}{1000} = 5.41437 \text{ kW}$$

$$\dot{E}_i = \frac{T_i * N}{1000} = 3.76735 \text{ kW}$$

$$\eta_i = \frac{\dot{E}_i}{\dot{E}} = 0.6958$$



Essai:

Date:

$$R_{1e} = \underline{0.19} \quad \text{m}$$

$$n_{11} = \frac{\dot{N}m * 2R}{\sqrt{H}} = \underline{132.1} \quad \text{t/min}$$

$$Q_{11} = \frac{\dot{V}}{4 * R^2 * \sqrt{H}} = \underline{0.25933} \quad \text{m}^3/\text{s}$$

$$\dot{E}_{11} = \frac{\dot{E}_i}{4 * R^2 * H^{3/2}} = \underline{1.267} \quad \text{kW}$$

Calculo de sigma

$$Pa - \text{corr} = 35229.0 \text{ N/m}^2 ; \Delta\mu * g = 123044.4 \text{ N/m}^3$$

$$H_a = \frac{Pa - \text{corr}}{\mu_e * g} = \underline{3.7214} \quad \text{mCE}$$

$$H_v = 0.055732958 + 0.005986614 * T_e^{\circ} + 0.00003165884 * (T_e^{\circ})^2 + 0.000006314287 * (T_e^{\circ})^3 =$$


$$H_v = 5.5732958 \times 10^{-2} + 5.986614 \times 10^{-3} * T_e^{\circ} + 3.165884 \times 10^{-5} (T_e^{\circ})^2 + 6.314287 \times 10^{-6} * (T_e^{\circ})^3 = \underline{0.18787} \quad \text{mCE}$$

$$\Delta P_{\sigma} = 123044.4 * 0.08233 * \left( \frac{105472}{20000} - 0.1284 \right) = 52540 \text{ N/m}^2$$

$$H_s = \frac{\Delta P}{\mu_e * g} = \underline{5.3635} \quad \text{mCE}$$

$$\sigma = \frac{H_a - H_v - H_s}{H} = \frac{NPSH}{H} = \underline{.6927}$$

| 328-02<br>No 1 |                   | Ensayo: Cavitation<br>Essai: Runner : 5-KN-35 |                                  |                    |                        |                           |                        |  |                            |                          |                         | Fecha: 03 Avr 92<br>Date: |               |                 |                         |                           |
|----------------|-------------------|---|----------------------------------|--------------------|------------------------|---------------------------|------------------------|--|----------------------------|--------------------------|-------------------------|---------------------------|---------------|-----------------|-------------------------|---------------------------|
| No             | $\alpha p$<br>(°) | $\gamma d$<br>(mm)                            | $\dot{V}$<br>(m <sup>3</sup> /s) | gH<br>(J/Kg)       | T <sub>i</sub><br>(Nm) | N <sub>m</sub><br>(t/min) | T <sub>e</sub><br>(°C) | $\eta$<br>(%)  | n <sub>11</sub><br>(t/min) | Q <sub>11</sub><br>(l/s) | P <sub>11</sub><br>(kW) | $\varphi$<br>(-)          | $\psi$<br>(-) | $\sigma$<br>(-) | H <sub>s</sub><br>(mCE) | N <sub>p</sub><br>(t/min) |
| 1.             | 6.0               | 9.0   | .0919                            | 58.993             | 42.21                  | 852.5                     | 16.20                  | 69.58  | 132.1                      | 259.4                    | 1.768                   | .0478                     | .4101         | .6927           | 5.364                   | 251.3                     |
| 2.             | 6.0               | 9.0   | .0920                            | 59.042             | 42.26                  | 852.5                     | 16.21                  | 69.34  | 132.0                      | 259.6                    | 1.768                   | .0478                     | .4105         | .5968           | 5.937                   | 251.3                     |
| 3.             | 6.0               | 12.4  | .1109                            | 59.086             | 38.56                  | 948.7                     | 16.22                  | 58.50  | 146.9                      | 313.0                    | 1.794                   | .0518                     | .3316         | .7368           | 5.091                   | 257.4                     |
| 4.             | 6.0               | 12.4  | .1112                            | 59.169             | 39.15                  | 948.5                     | 16.24                  | 59.19  | 146.7                      | 313.4                    | 1.817                   | .0519                     | .3322         | .8558           | 4.366                   | 257.4                     |
|                |                   |   |                                  |                    |                        |                           |                        |  |                            |                          |                         |                           |               |                 |                         |                           |
| GABRIEL TERRA  |                   | U.T.E.  |                                  | GEC ALSTHOM NEYRPI |                        | IMHEF                     |                        | INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE |                            |                          |                         |                           |               |                 |                         |                           |

Pu UTE  100 EDF   
 100 EDF  



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

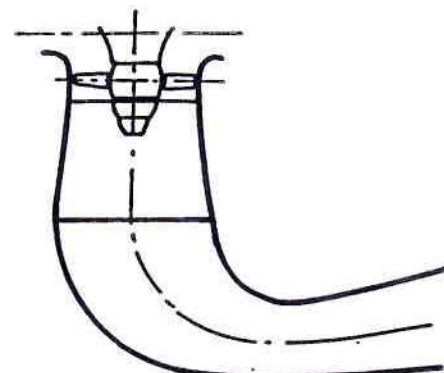
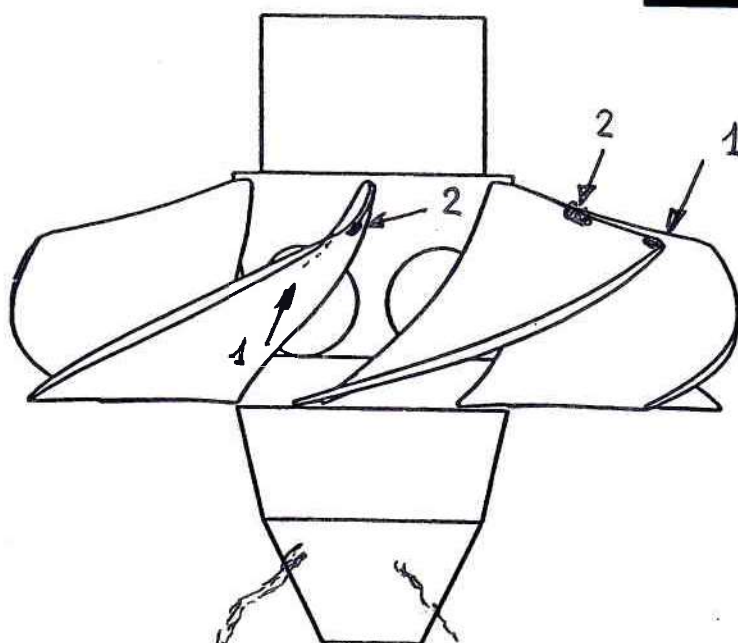
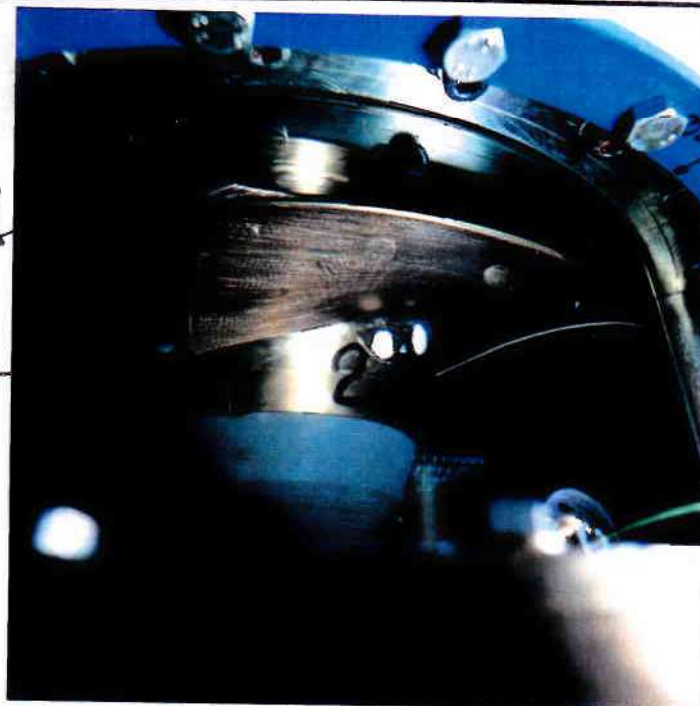
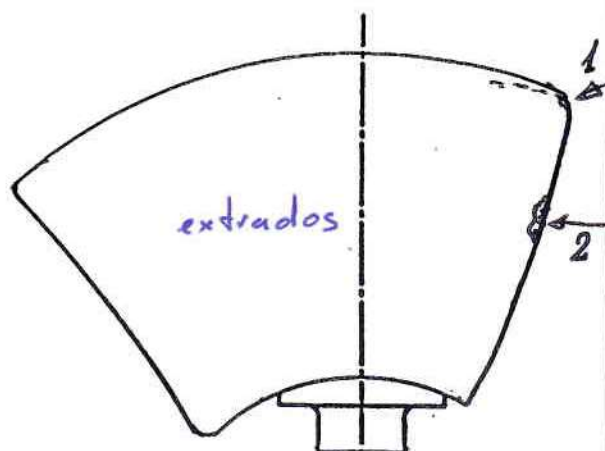
328-02-02 GABRIEL TERRA

NEYRPIC

Date:

03/04/92

$$\sigma = 0.6927$$



Mesure: 1  
 $\alpha_p$ : 6°  
 $\gamma_d$ : 3mm Hp: 21m  
Film: 1 Photo: 2.3

Commentaires:

1: intermittent

2: sporadique

pour IMHEF

Pour VTE

pour EDF

12

pour NP

**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

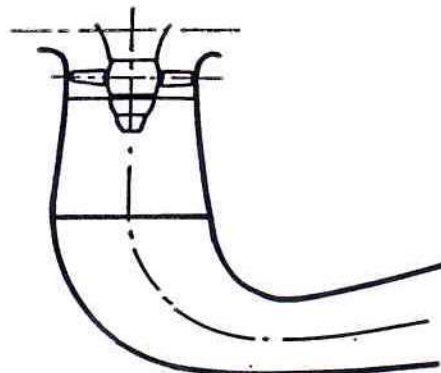
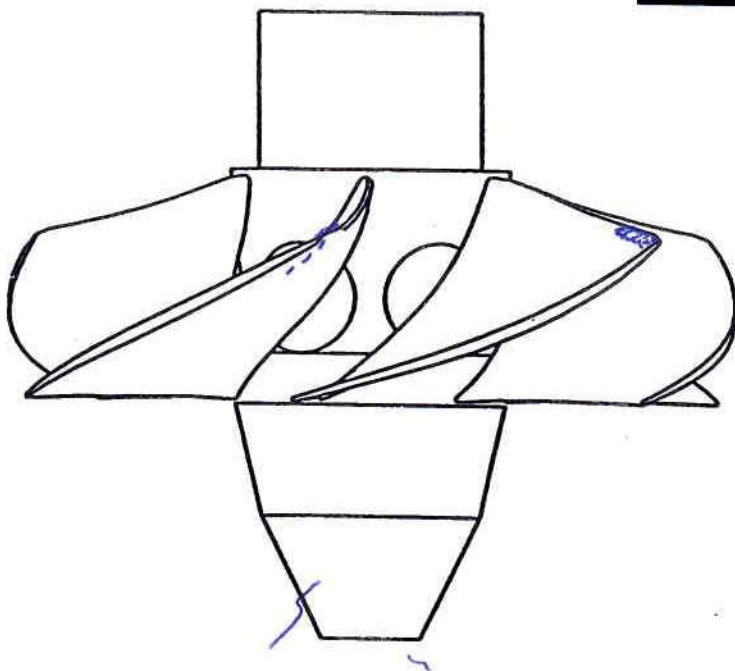
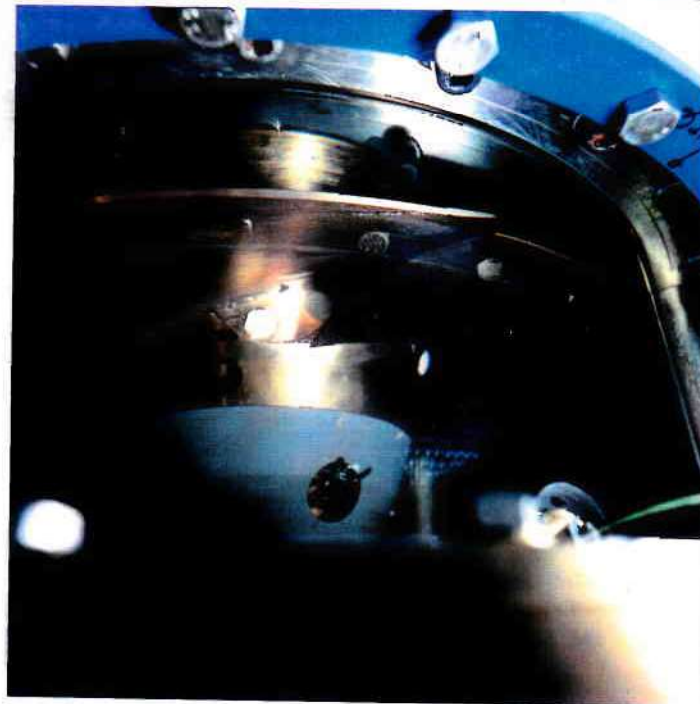
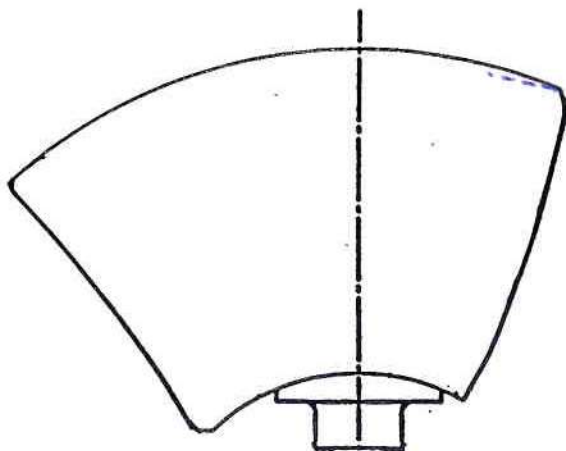
328-02-03 GABRIEL TERRA

NEYRPIC

Date:

03 AVR 92

$$\sigma = 0,5968$$



Mesure: 2  
 $\alpha-p$ : 6°  
 $\gamma-d$ : 9mm  $H_p$ : 21m  
Film: 1 Photo: 4.5

Commentaires:

legère cavitation intermittente intrados

petite tache sporadique

pour IMHEF

*HP* *h.h.*

for UTE

*Gabriel Terra*  
*Réunion*

10m EDF

*+2*

pour NP

*Pucelle*

**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

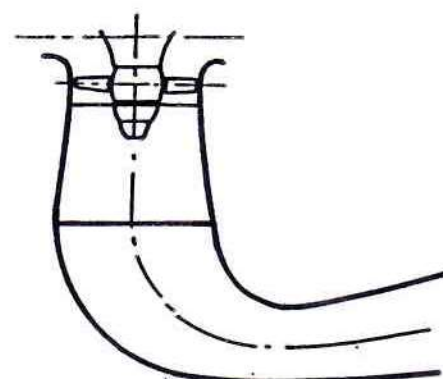
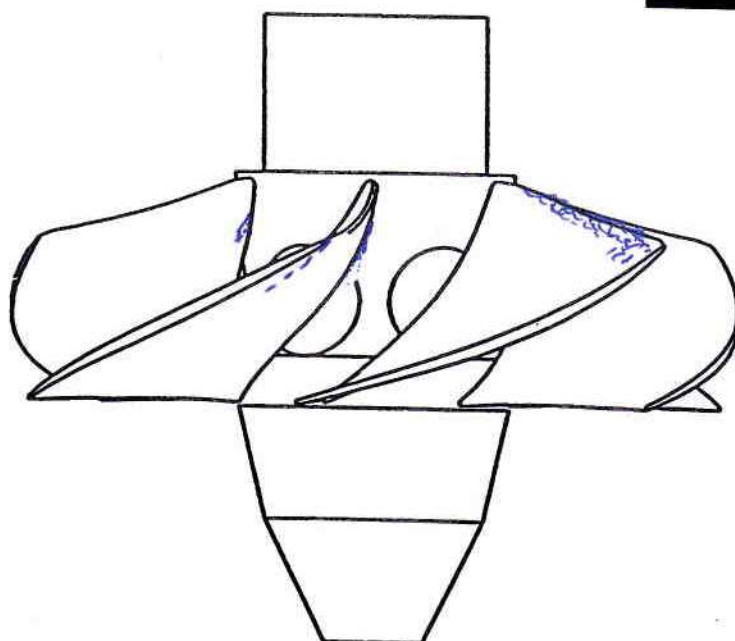
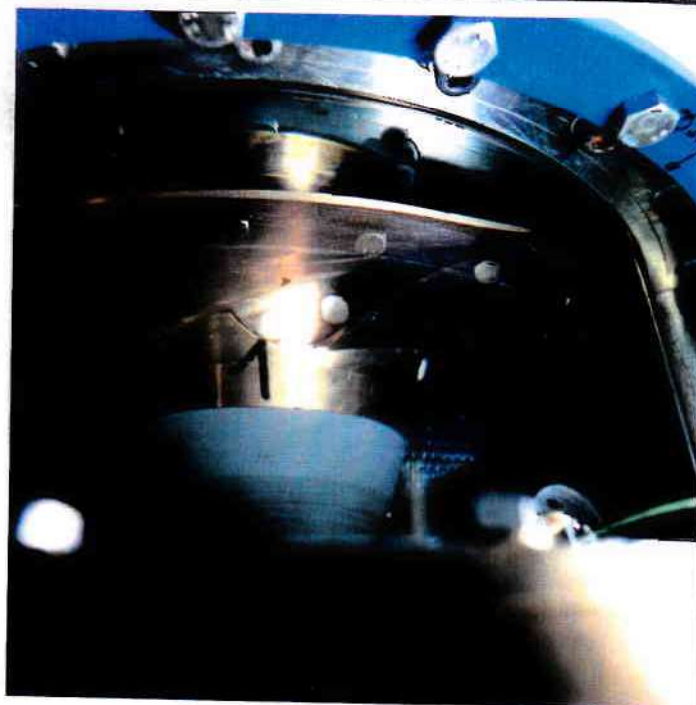
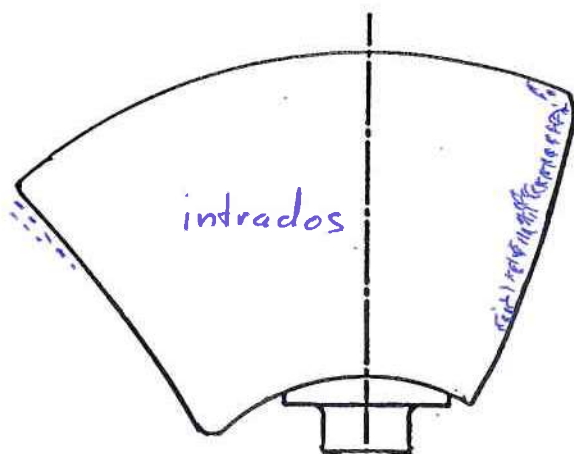
328-02-04 GABRIEL TERRA

NEYRPIC

Date:

03 AVR 92

$$\sigma = 0.737$$



Mesure: 3  
 $\alpha_p$ : 6°  
 $\gamma_d$ : 12.4 mm Hp: 17 m  
Film: 1 Photo: 6.7

Commentaires:

Pour UTF

H. M. M. M. M.

pour EDF

pour AP

pour IMHEF





Essai:

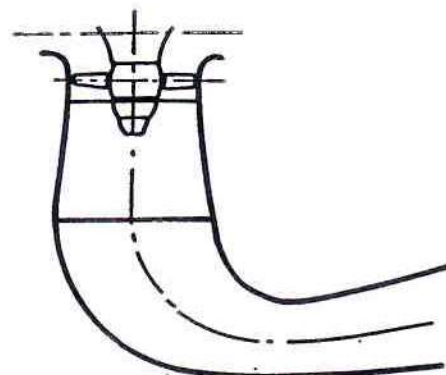
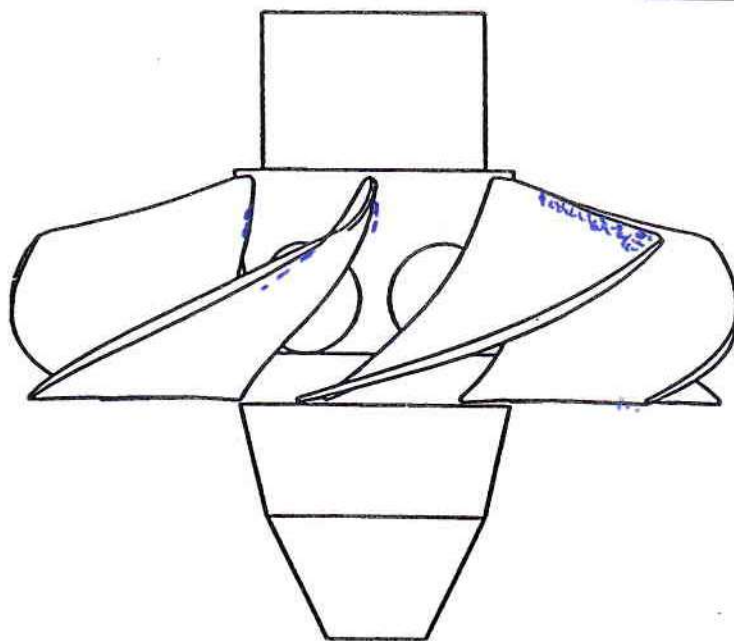
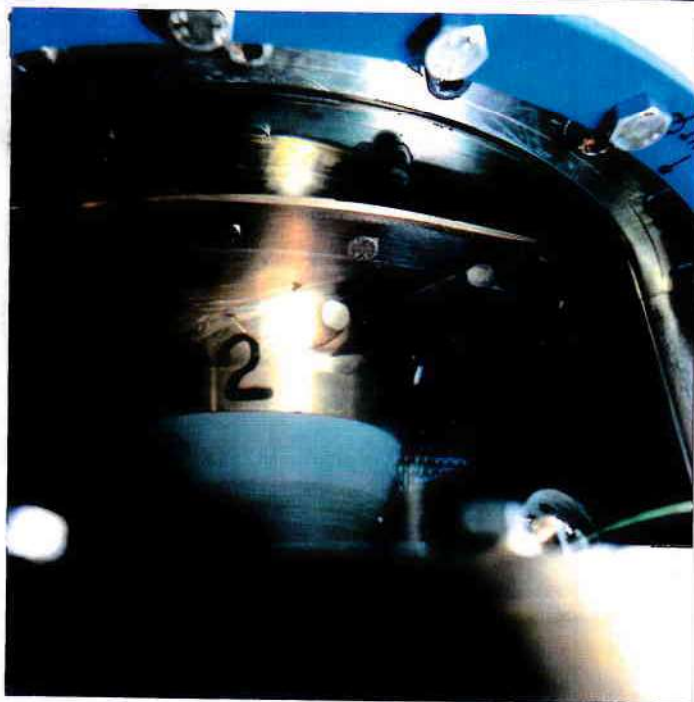
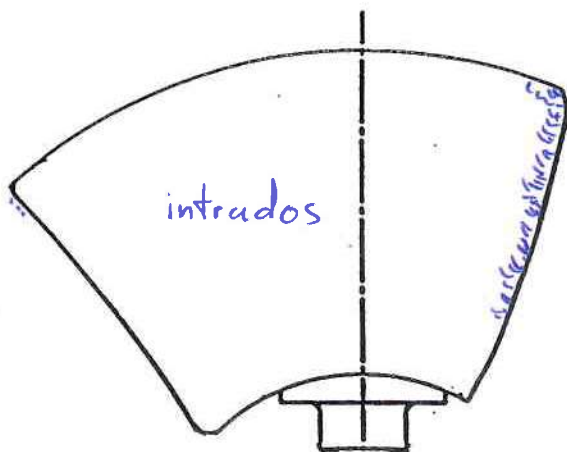
328-02-05 GABRIEL TERRA

NEYRPIC

Date:

03 AVR 92

$$\sigma = 0.8558$$



Mesure: 4  
 $\alpha_p$ : 6°  
 $\gamma_d$ : 12.4 mm Hp: 17 m  
Film: 1 Photo: 8.9

Commentaires:


Par UTE

pour EDF

pour NP

pour IMHEF

| 328-02<br>Nº 06 |                   | Ensayo : Cavitation<br>Essai: Runner : 5-KN-35 |                     |              |            |               |            |               |                |              |             | Fecha: 03 AVR 92<br>Date: |               |                 |             |               |
|-----------------|-------------------|--|---------------------|--------------|------------|---------------|------------|---------------|----------------|--------------|-------------|---------------------------|---------------|-----------------|-------------|---------------|
| No              | $\alpha_p$<br>(°) | $\chi_d$<br>(mm)                               | $\dot{V}$<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | $\eta$<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | $\varphi$<br>(-)          | $\psi$<br>(-) | $\sigma$<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 5.              | 32.5              | 34.8   | .5693               | 58.990       | 339.76     | 852.7         | 16.63      | 90.44         | 132.1          | 1607.5       | 14.240      | .2959                     | .4099         | 1.5884          | .002        | 460.6         |
| 6.              | 32.5              | 34.8   | .5691               | 58.888       | 338.83     | 852.6         | 16.65      | 90.38         | 132.2          | 1608.2       | 14.237      | .2958                     | .4093         | 1.1806          | 2.467       | 460.3         |
| 7.              | 32.5              | 34.8   | .5684               | 58.872       | 338.72     | 852.7         | 16.67      | 90.49         | 132.2          | 1606.5       | 14.239      | .2954                     | .4091         | 1.0708          | 3.127       | 460.3         |
| 8.              | 32.5              | 34.8   | .5684               | 58.881       | 338.62     | 852.7         | 16.68      | 90.45         | 132.2          | 1606.4       | 14.233      | .2954                     | .4091         | .9529           | 3.835       | 460.3         |
| 9.              | 32.5              | 34.8   | .5692               | 58.902       | 338.69     | 852.8         | 16.70      | 90.32         | 132.2          | 1608.4       | 14.229      | .2958                     | .4092         | .8565           | 4.411       | 460.3         |
| 10.             | 32.5              | 34.8   | .5687               | 58.955       | 339.37     | 852.7         | 16.71      | 90.50         | 132.2          | 1606.1       | 14.236      | .2955                     | .4096         | .7442           | 5.082       | 460.3         |
| 11.             | 32.5              | 34.8   | .5679               | 58.982       | 339.27     | 852.7         | 16.73      | 90.55         | 132.1          | 1603.7       | 14.224      | .2951                     | .4098         | .6922           | 5.392       | 460.3         |
| 12.             | 32.5              | 34.8   | .5686               | 59.293       | 341.22     | 852.3         | 16.86      | 90.44         | 131.7          | 1601.4       | 14.186      | .2956                     | .4123         | .5965           | 5.948       | 460.3         |
| 13.             | 32.5              | 34.8   | .5663               | 59.462       | 341.37     | 852.5         | 16.97      | 90.62         | 131.6          | 1592.5       | 14.134      | .2944                     | .4133         | .5168           | 6.430       | 459.3         |
| 14.             | 32.5              | 34.8   | .5638               | 58.808       | 333.62     | 852.5         | 16.99      | 89.93         | 132.3          | 1594.5       | 14.045      | .2931                     | .4088         | .4581           | 6.816       | 457.1         |
| 15.             | 32.5              | 34.8   | .5642               | 58.925       | 330.64     | 852.4         | 17.01      | 88.88         | 132.1          | 1594.0       | 13.876      | .2933                     | .4097         | .4337           | 6.957       | 457.3         |
| 16.             | 32.5              | 34.8   | .5630               | 59.534       | 317.72     | 852.4         | 17.02      | 84.72         | 131.5          | 1582.4       | 13.130      | .2927                     | .4139         | .3784           | 7.265       | 457.3         |
| 17.             | 30.6              | 32.3   | .5215               | 59.064       | 311.51     | 852.6         | 17.06      | 90.40         | 132.0          | 1471.6       | 13.029      | .2711                     | .4105         | 1.5878          | -.001       | 432.3         |
| 18.             | 30.6              | 32.3   | .5222               | 59.091       | 311.62     | 852.7         | 17.07      | 90.28         | 132.0          | 1473.3       | 13.027      | .2714                     | .4106         | 1.1901          | 2.391       | 432.3         |
| 19.             | 30.6              | 32.3   | .5217               | 59.096       | 311.68     | 852.7         | 17.08      | 90.38         | 132.0          | 1471.7       | 13.028      | .2711                     | .4106         | 1.0224          | 3.401       | 432.3         |
| 20.             | 30.6              | 32.3   | .5211               | 58.898       | 309.83     | 852.6         | 17.09      | 90.24         | 132.2          | 1472.6       | 13.015      | .2709                     | .4093         | .8936           | 4.195       | 431.7         |
| 21.             | 30.6              | 32.3   | .5214               | 59.151       | 312.12     | 852.6         | 17.09      | 90.47         | 131.9          | 1470.1       | 13.027      | .2710                     | .4111         | .7935           | 4.775       | 432.4         |
| 22.             | 30.6              | 32.3   | .5214               | 59.170       | 312.50     | 852.6         | 17.10      | 90.56         | 131.9          | 1469.8       | 13.037      | .2710                     | .4112         | .6688           | 5.527       | 432.4         |
| 23.             | 30.6              | 32.3   | .5220               | 59.161       | 312.48     | 852.6         | 17.12      | 90.45         | 131.9          | 1471.8       | 13.039      | .2713                     | .4112         | .5983           | 5.952       | 432.3         |
| 24.             | 30.6              | 32.3   | .5215               | 59.198       | 312.99     | 852.6         | 17.17      | 90.62         | 131.9          | 1470.0       | 13.047      | .2711                     | .4115         | .5019           | 6.531       | 432.3         |
| 25.             | 30.6              | 32.3   | .5196               | 59.169       | 312.41     | 852.6         | 17.18      | 90.84         | 131.9          | 1465.0       | 13.034      | .2701                     | .4112         | .4417           | 6.896       | 431.0         |
| 26.             | 30.6              | 32.3   | .5188               | 58.962       | 310.33     | 852.8         | 17.19      | 90.71         | 132.2          | 1465.2       | 13.018      | .2696                     | .4096         | .4053           | 7.124       | 430.3         |
| 27.             | 30.6              | 32.3   | .5181               | 58.993       | 304.91     | 852.7         | 17.20      | 89.19         | 132.1          | 1462.8       | 12.779      | .2693                     | .4099         | .3655           | 7.362       | 430.3         |
| 28.             | 31.3              | 29.9   | .4796               | 58.783       | 320.95     | 765.5         | 17.26      | 91.38         | 118.8          | 1356.6       | 12.141      | .2776                     | .5067         | 1.5955          | -.004       | 408.3         |
| 29.             | 31.3              | 29.9   | .4803               | 58.787       | 321.10     | 765.5         | 17.26      | 91.28         | 118.8          | 1358.5       | 12.145      | .2780                     | .5068         | 1.1953          | 2.395       | 408.3         |
| 30.             | 31.3              | 29.9   | .4804               | 58.796       | 320.83     | 765.5         | 17.27      | 91.18         | 118.8          | 1358.6       | 12.132      | .2781                     | .5069         | 1.0313          | 3.377       | 408.3         |
| 31.             | 31.3              | 29.9   | .4803               | 58.819       | 321.17     | 765.5         | 17.27      | 91.24         | 118.8          | 1358.2       | 12.137      | .2781                     | .5072         | .9092           | 4.106       | 408.3         |
| 32.             | 31.3              | 29.9   | .4803               | 58.840       | 321.34     | 765.3         | 17.28      | 91.25         | 118.7          | 1357.8       | 12.135      | .2781                     | .5075         | .8075           | 4.715       | 408.3         |
| 33.             | 31.3              | 29.9   | .4804               | 58.827       | 321.12     | 765.4         | 17.28      | 91.19         | 118.8          | 1358.3       | 12.131      | .2781                     | .5073         | .7106           | 5.297       | 408.3         |
| 34.             | 31.3              | 29.9   | .4797               | 58.893       | 321.64     | 765.5         | 17.29      | 91.38         | 118.7          | 1355.4       | 12.131      | .2777                     | .5078         | .6078           | 5.910       | 408.3         |
| 35.             | 31.3              | 29.9   | .4794               | 59.049       | 322.78     | 765.4         | 17.30      | 91.51         | 118.5          | 1352.9       | 12.126      | .2776                     | .5092         | .5413           | 6.300       | 408.3         |
| 36.             | 31.3              | 29.9   | .4778               | 58.978       | 321.81     | 765.5         | 17.33      | 91.65         | 118.6          | 1349.4       | 12.111      | .2766                     | .5085         | .4838           | 6.649       | 407.3         |
| 37.             | 31.3              | 29.9   | .4761               | 58.830       | 320.18     | 765.5         | 17.36      | 91.75         | 118.8          | 1346.1       | 12.097      | .2756                     | .5072         | .4506           | 6.855       | 406.3         |
| 38.             | 31.3              | 29.9   | .4746               | 58.851       | 319.10     | 765.5         | 17.37      | 91.70         | 118.7          | 1341.6       | 12.049      | .2747                     | .5074         | .4143           | 7.072       | 405.3         |
| 39.             | 31.3              | 29.9   | .4739               | 58.631       | 316.10     | 765.5         | 17.37      | 91.31         | 119.0          | 1342.2       | 12.003      | .2744                     | .5055         | .3621           | 7.404       | 404.3         |
| 40.             | 31.6              | 36.6   | .6217               | 58.879       | 309.46     | 975.5         | 17.56      | 86.48         | 151.3          | 1757.0       | 14.881      | .2824                     | .3126         | 1.5897          | .012        | 492.4         |
| 41.             | 31.6              | 36.6   | .6222               | 58.966       | 310.45     | 975.5         | 17.58      | 86.56         | 151.2          | 1757.1       | 14.895      | .2826                     | .3130         | 1.1768          | 2.480       | 492.4         |
| 42.             | 31.6              | 36.6   | .6207               | 58.716       | 307.45     | 975.7         | 17.60      | 86.31         | 151.5          | 1756.6       | 14.848      | .2819                     | .3116         | 1.0696          | 3.152       | 491.4         |



**IMHFP**  
INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MECANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

**GABRIEL TERRA**

**U.T.E.**

**GEC ALSTHOM NEYRPIC**



INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

GEC ALSTHOM NEYRPEC

U.T.E.

GABRIEL TERRA

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

| 328-02<br>Nº 16 |                   | Ensayo : Cavitation<br>Essai: Runner : 5-KN-35 |                                  |                     |                        |                           |                        |  |                            |                          |                         | Fecha: 04 AVR 92<br>Date: |               |                 |                         |                           |
|-----------------|-------------------|--|----------------------------------|---------------------|------------------------|---------------------------|------------------------|--|----------------------------|--------------------------|-------------------------|---------------------------|---------------|-----------------|-------------------------|---------------------------|
| No              | $\alpha_p$<br>(°) | $\gamma_d$<br>(mm)                             | $\dot{V}$<br>(m <sup>3</sup> /s) | gH<br>(J/Kg)        | T <sub>i</sub><br>(Nm) | N <sub>m</sub><br>(t/min) | T <sub>e</sub><br>(°C) | $\eta$<br>(%)  | n <sub>11</sub><br>(t/min) | Q <sub>11</sub><br>(l/s) | P <sub>11</sub><br>(kW) | $\varphi$<br>(-)          | $\psi$<br>(-) | $\sigma$<br>(-) | H <sub>s</sub><br>(mCE) | N <sub>p</sub><br>(t/min) |
| 43.             | 31.6              | 36.6   | .6205                            | 58.790              | 307.96                 | 975.7                     | 17.62                  | 86.36  | 151.4                      | 1755.1                   | 14.844                  | .2819                     | .3120         | .9452           | 3.890                   | 491.4                     |
| 44.             | 31.6              | 36.6   | .6202                            | 58.793              | 308.31                 | 975.6                     | 17.66                  | 86.50  | 151.4                      | 1754.0                   | 14.859                  | .2817                     | .3121         | .8658           | 4.365                   | 491.4                     |
| 45.             | 31.6              | 36.6   | .6205                            | 58.770              | 308.68                 | 975.5                     | 17.78                  | 86.58  | 151.4                      | 1755.4                   | 14.885                  | .2819                     | .3120         | .7854           | 4.847                   | 491.4                     |
| 46.             | 31.6              | 36.6   | .6198                            | 58.870              | 309.09                 | 975.5                     | 17.84                  | 86.66  | 151.3                      | 1751.9                   | 14.867                  | .2816                     | .3125         | .6889           | 5.418                   | 491.4                     |
| 47.             | 31.6              | 36.6   | .6199                            | 58.902              | 310.14                 | 975.4                     | 17.86                  | 86.88  | 151.2                      | 1751.7                   | 14.903                  | .2816                     | .3127         | .6358           | 5.734                   | 491.4                     |
| 48.             | 31.6              | 36.6   | .6185                            | 58.692              | 308.98                 | 975.4                     | 17.88                  | 87.06  | 151.5                      | 1750.9                   | 14.927                  | .2810                     | .3116         | .5842           | 6.056                   | 490.4                     |
| 49.             | 31.6              | 36.6   | .6166                            | 58.885              | 301.74                 | 975.4                     | 17.90                  | 85.01  | 151.3                      | 1742.5                   | 14.506                  | .2801                     | .3127         | .5091           | 6.496                   | 489.4                     |
| 50.             | 31.6              | 36.6   | .6205                            | 58.633              | 296.08                 | 975.4                     | 17.92                  | 83.24  | 151.6                      | 1757.4                   | 14.325                  | .2819                     | .3113         | .4776           | 6.697                   | 491.4                     |
| GABRIEL TERRA   |                   | U.T.E.   |                                  | GEC ALSTHOM NEYRPEC |                        | IMHEF                     |                        | INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MECANIQUE DES FLUIDES<br>ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE |                            |                          |                         |                           |               |                 |                         |                           |

*Handwritten signature*

*Handwritten signature*

*Handwritten signature* per EDF





Essai:

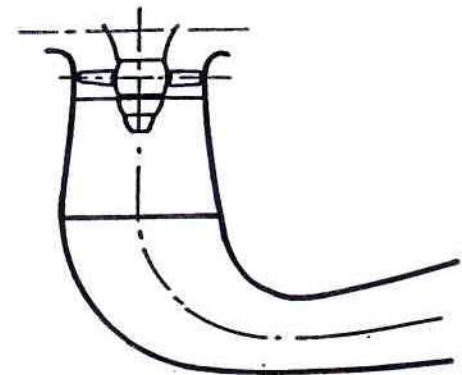
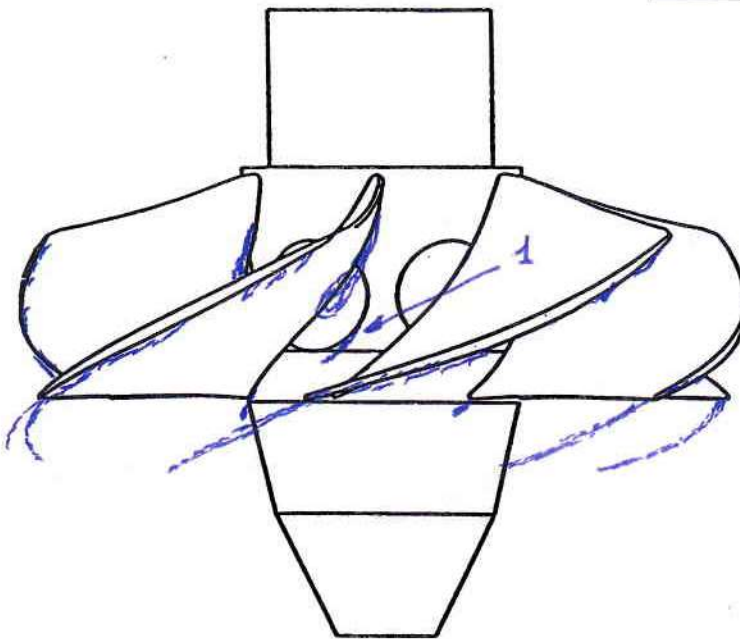
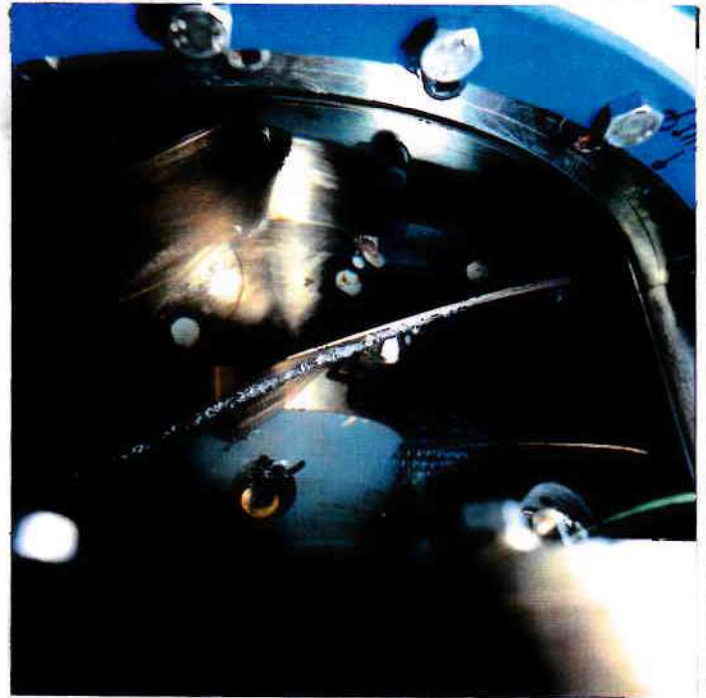
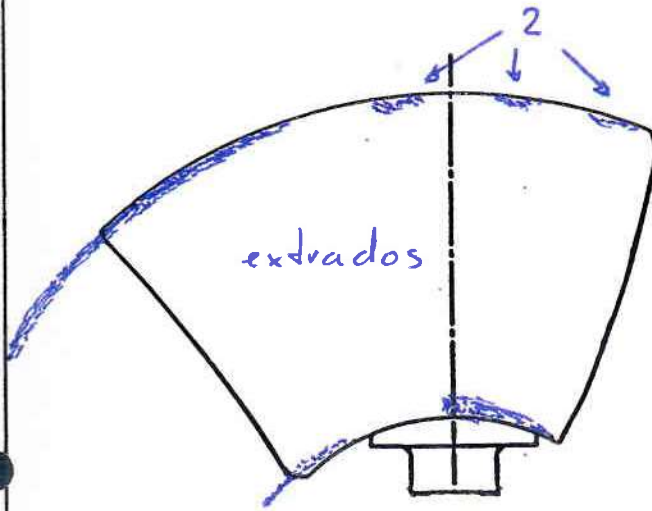
328.02.08 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = 0.6922$$



Mesure: 11  
 $\alpha-p$  : 32.5  
 $\gamma-d$  : 34.8 mm  $H_p$  : 21 m  
 Film : 1 Photo: 10.11.12

Commentaires:

1: seulement aubes 2 et 3

2: intermittent

pour IMHEF

*HPK ch.*

Pour UTE

*[Signature]**[Signature]*

pour EDF

*[Signature]*pour NP *[Signature]*

**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

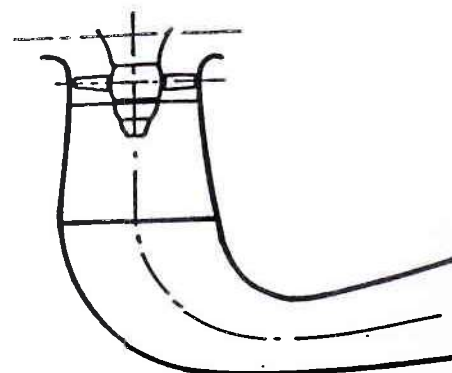
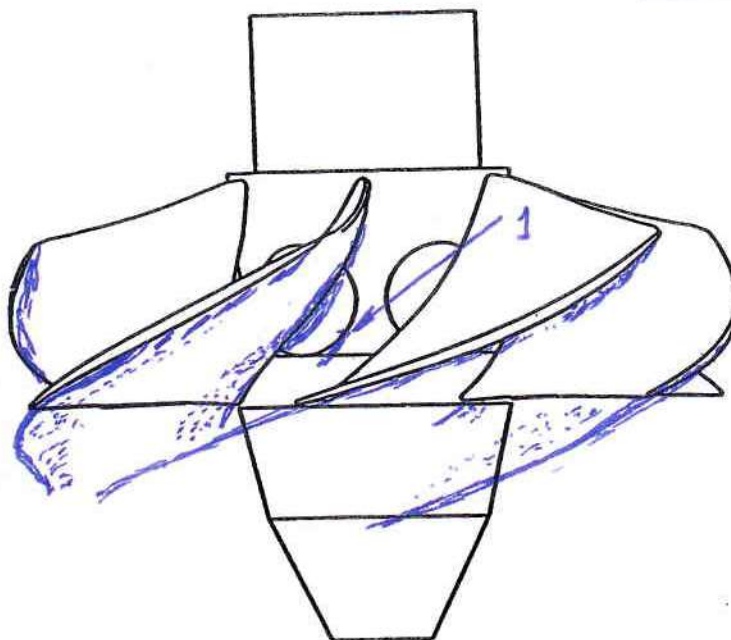
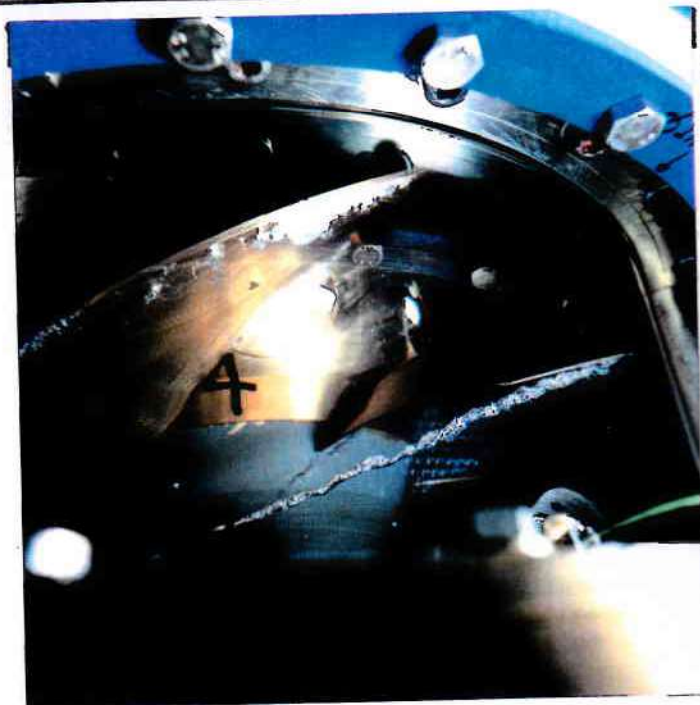
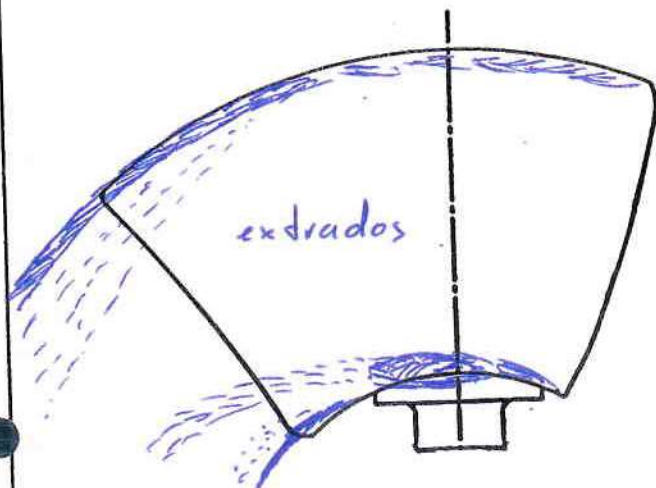
328-02-09 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = 0.5965$$



Mesure: 12

 $\alpha_p$ : 32.5° $\gamma_d$ : 34.8 mm Hp: 21 m

Film: 2 Photo: 2.3

Commentaires:

1: seulement sur aubes 2 et 3

Par VTE

pour IMHEF

pour EDF

pour VP



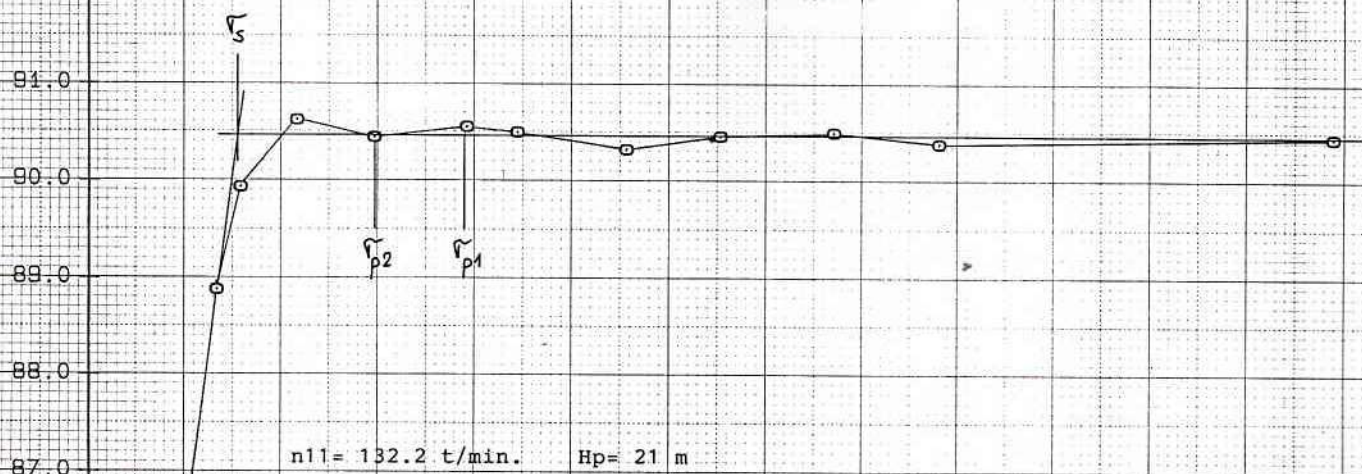
Cavitation

Roue : 5-KN-35

03 AVR 92

Alpha<sub>p</sub>=32.5 deg. Gamma<sub>d</sub>=34.7 mm.

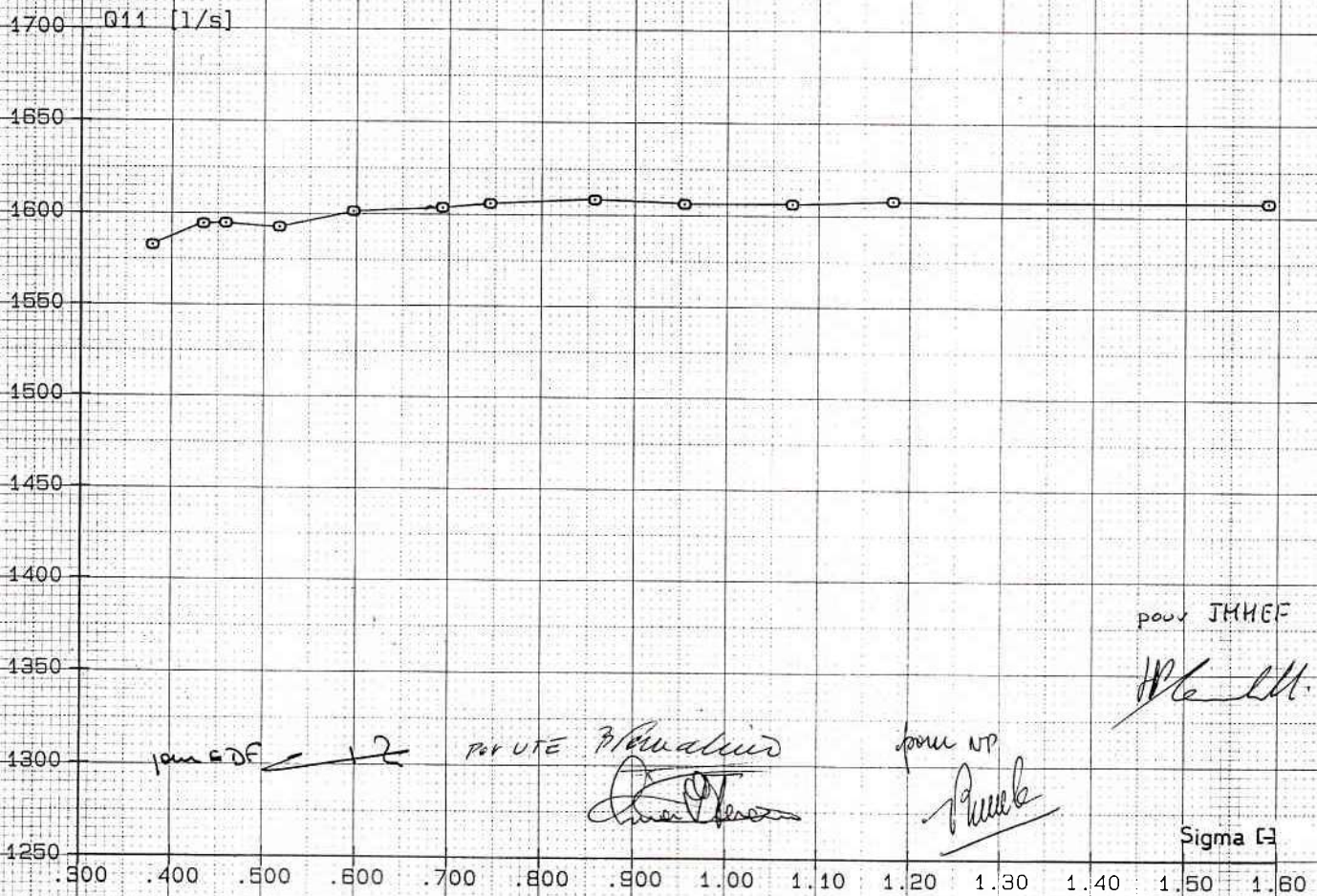
Eta [%]



n11= 132.2 t/min.

Hp= 21 m

Q11 [1/s]



pour IMHEF

HPG M.

pour EDF

pour UTE 3/4 actualisé

pour UP

Sigma [-]





Essai:

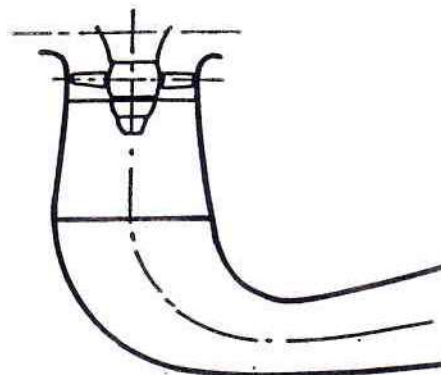
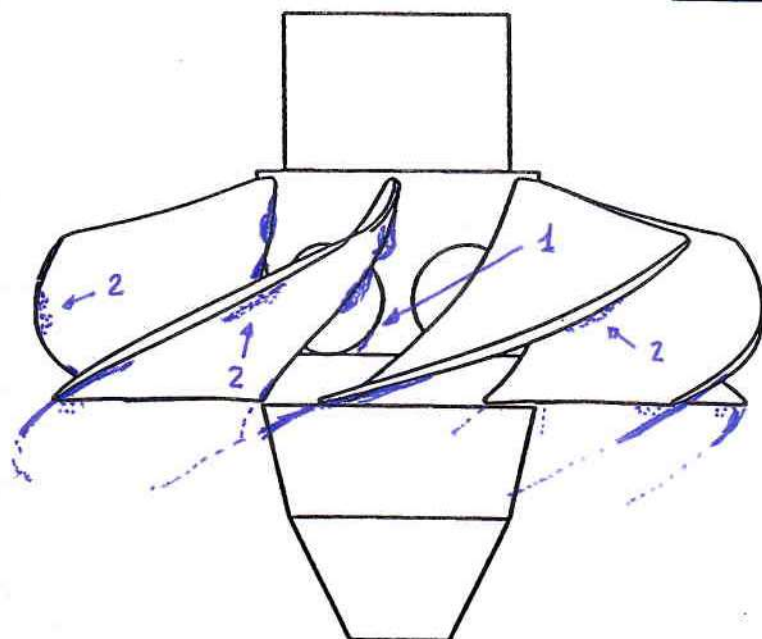
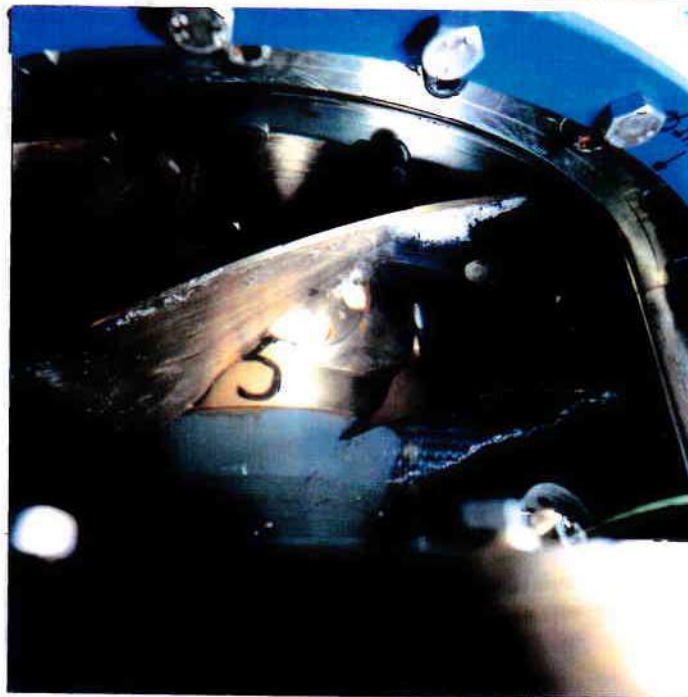
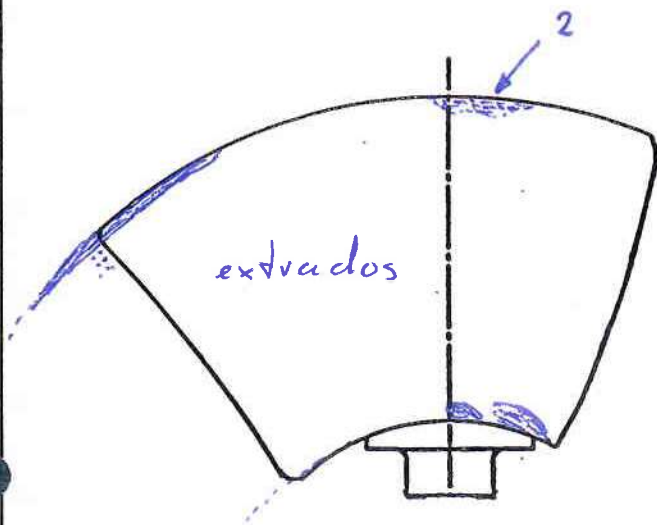
328-02-11 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = 0.5983$$



Mesure: 23  
 $\alpha_p$ : 30.6°  
 $\delta_d$ : 32.3 mm  $H_p$ : 21 m  
 Film: 2 Photo: 4.5

Commentaires:

1: seulement sur aubes 2 et 3  
 2: intermittent

Par VTE *Bruno Malin*  
*Gabriel Terra*

pour IMHEF

*HP 6.01.*

pour EDF

*+7*

pour NP

*Ruebe*



328-02-10 GABRIEL TERRA

U.T.E.

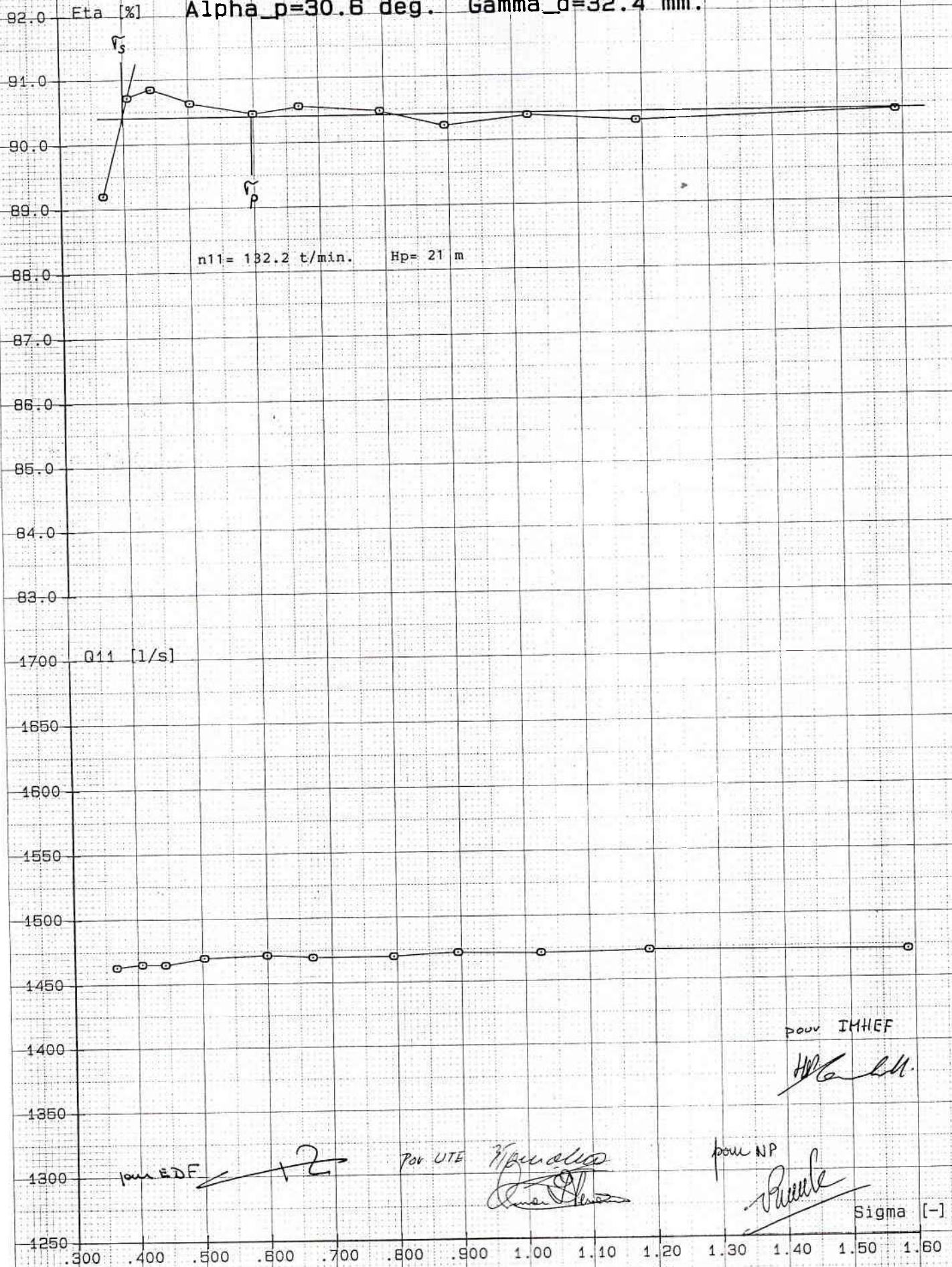
EPFL/IMHEF

Cavitation

Roue : 5-KN-35

03 AVR 92

Alpha\_p=30.6 deg. Gamma\_d=32.4 mm.





**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

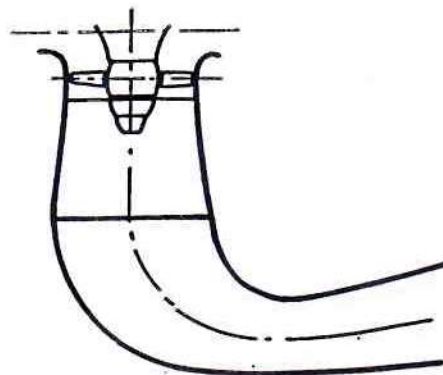
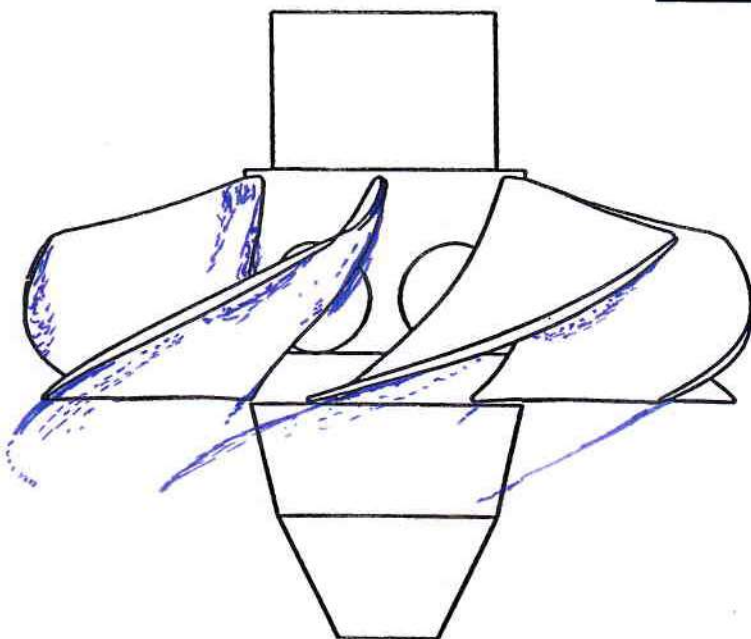
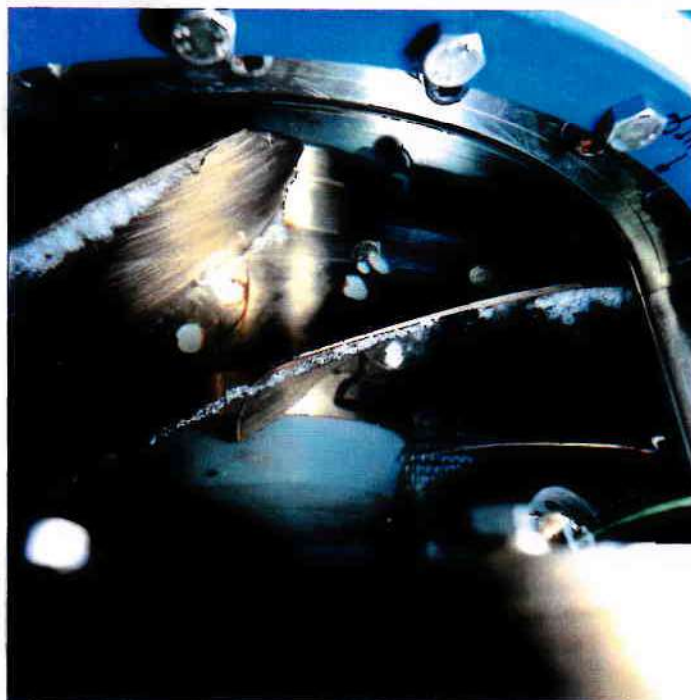
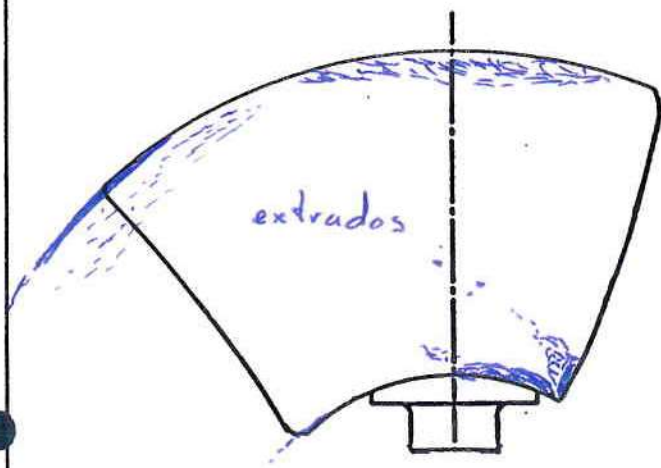
328-02-13 GABRIEL TERRA

NEYRPIC

Date:

'4 AVR 92

$$\sigma = 0.5413$$



Mesure: 35

 $\alpha_p : 31.3^\circ$  $\gamma_d : 29.9 \text{ mm}$   $H_p : 26 \text{ m}$ 

Film : 2 Photo: 6.7

Commentaires:

Per UTE

pour EDF

pour NP

+2

pour IMHEF



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

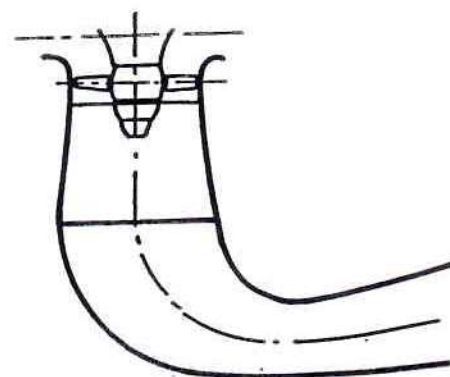
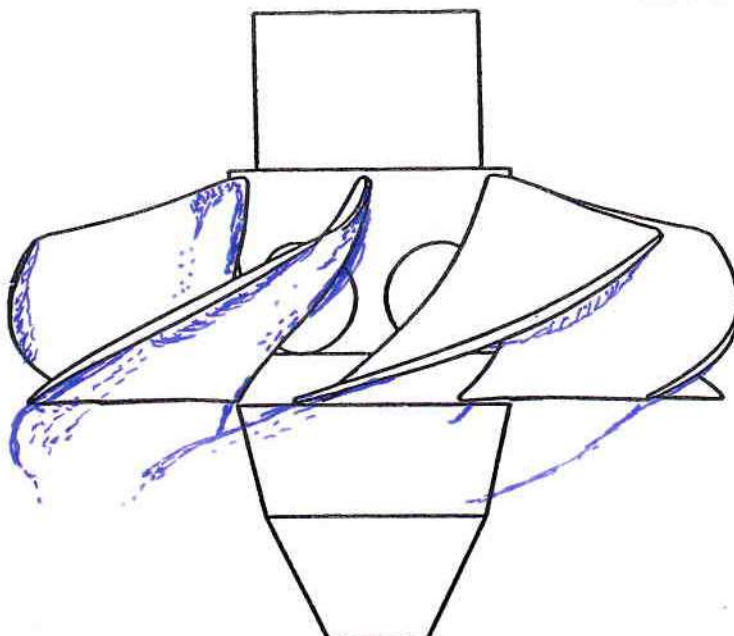
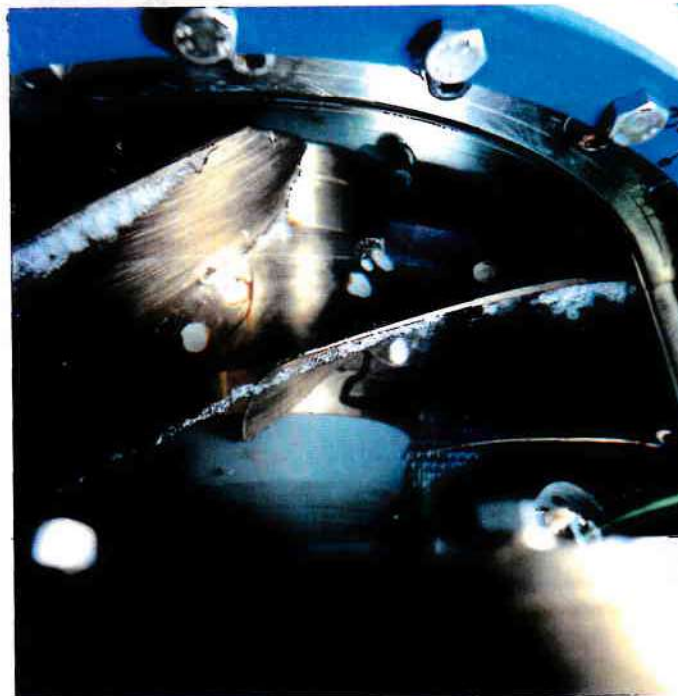
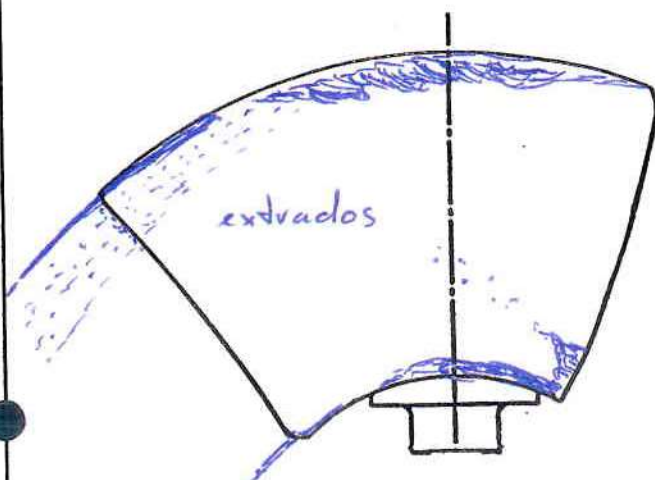
328-02-14 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = 0.4838$$



Mesure: 36  
 $\alpha_p$ : 31.3°  
 $\gamma_d$ : 29.8 mm  $H_p$ : 26 m  
Film: 2 Photo: 8.9

Commentaires:

Par VTE

pour EDF

pour NPP

Mauratius

pour IMHEF



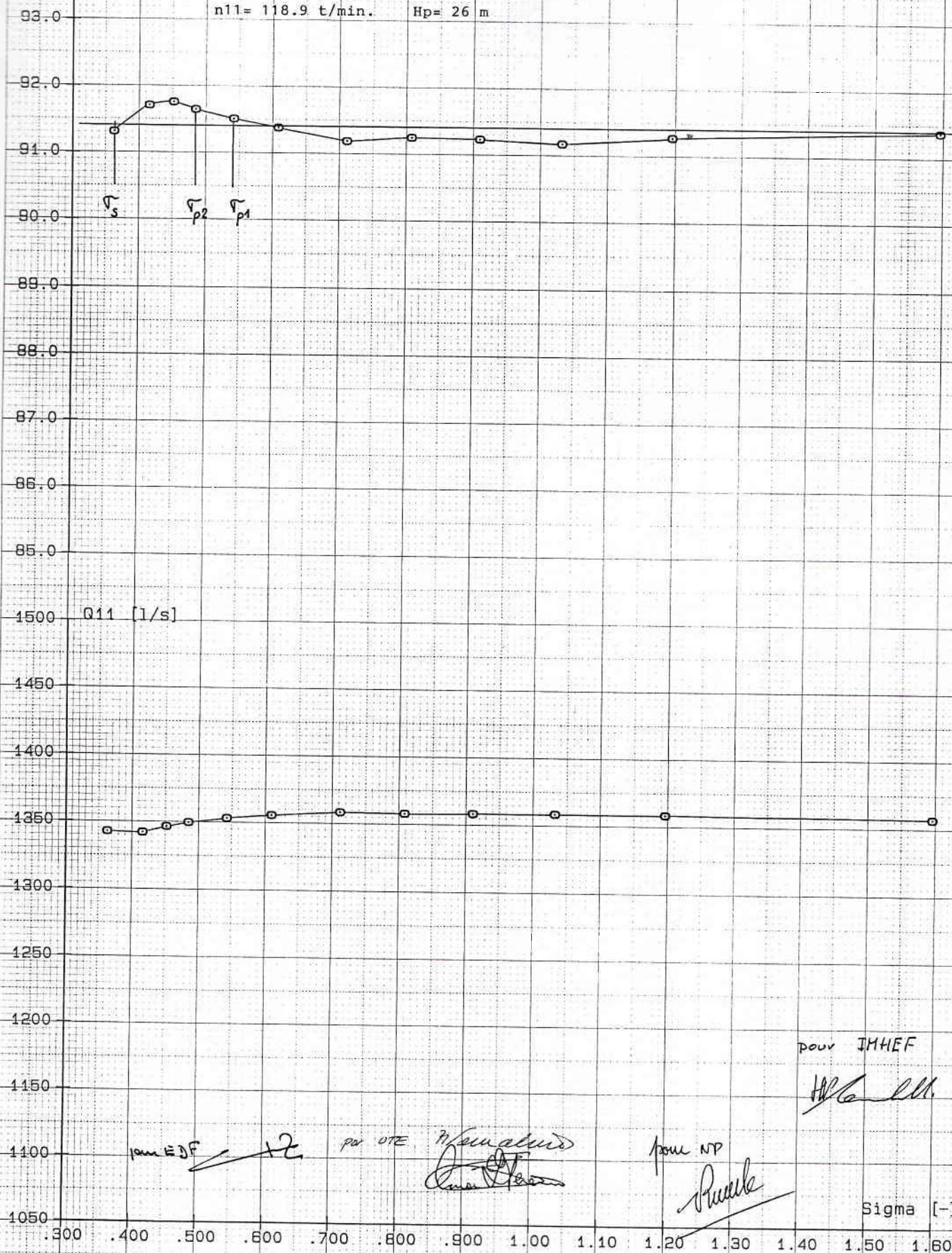
Cavitation

Roue : 5-KN-35

04 AVR 92

Eta [%] Alpha<sub>p</sub>=31.3 deg. Gamma<sub>d</sub>=29.9 mm.

n11= 118.9 t/min. Hp= 26 m





**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

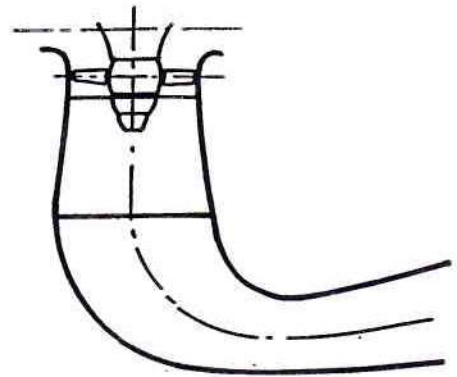
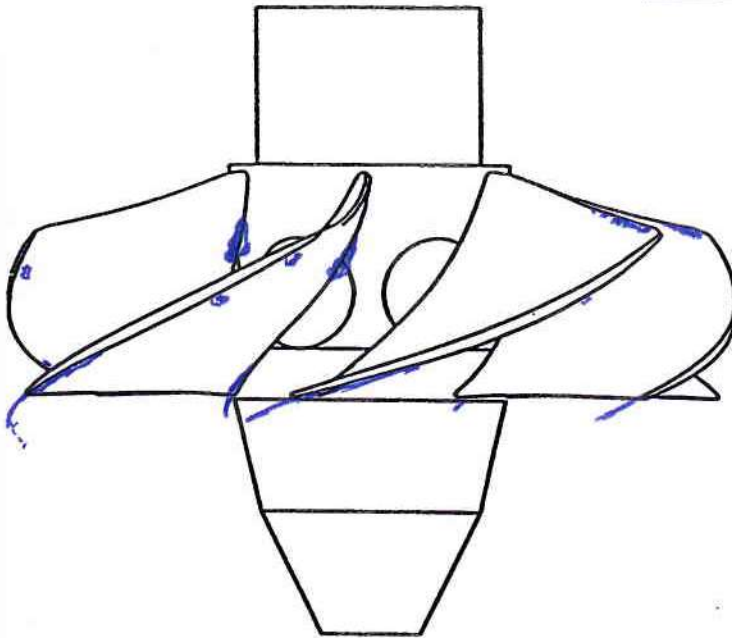
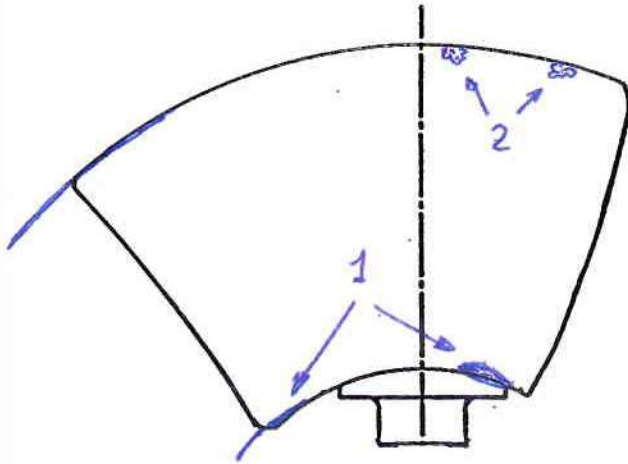
328-02-17 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = \underline{0.8658}$$



Mesure: 44

 $\alpha_p$  : 31.6° $\gamma_d$  : 36.6 mm Hp : 16 m

Film : 2 Photo: 10, 11

Commentaires:

1: seulement sur les aubes 2, 3, 4 et 5

2: intermittent

Per UTE

pour EDF

pour NP

pour IMHEF



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

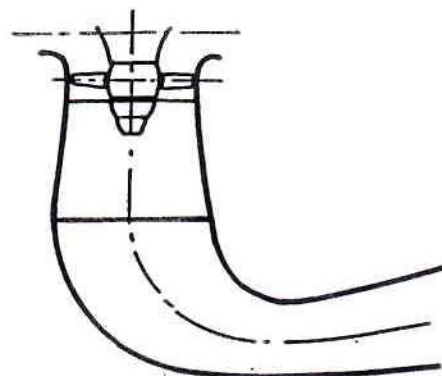
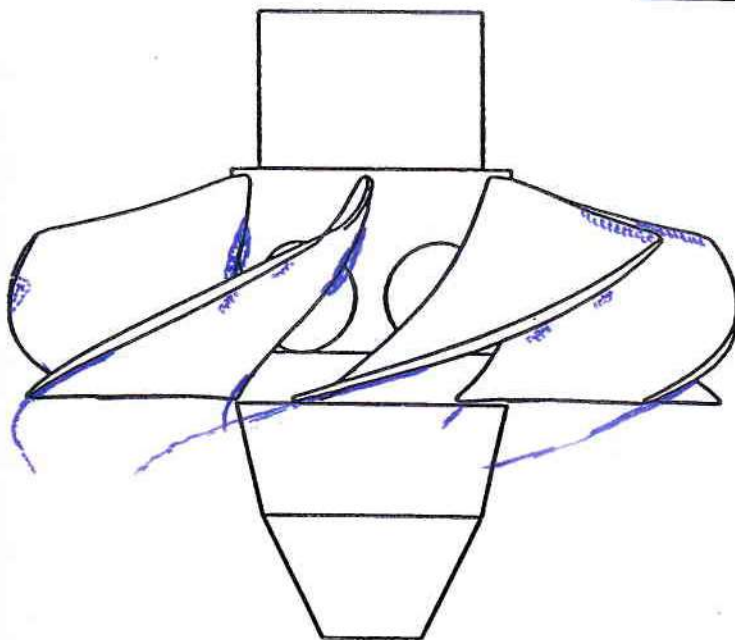
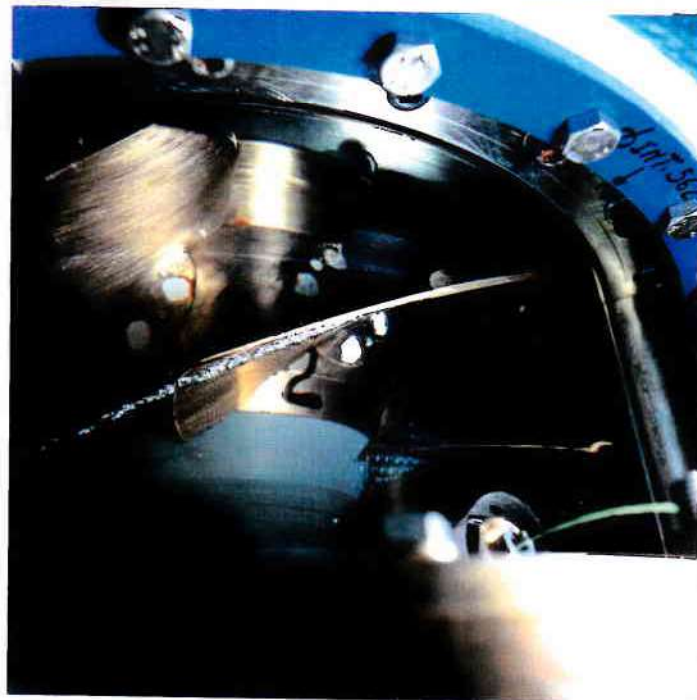
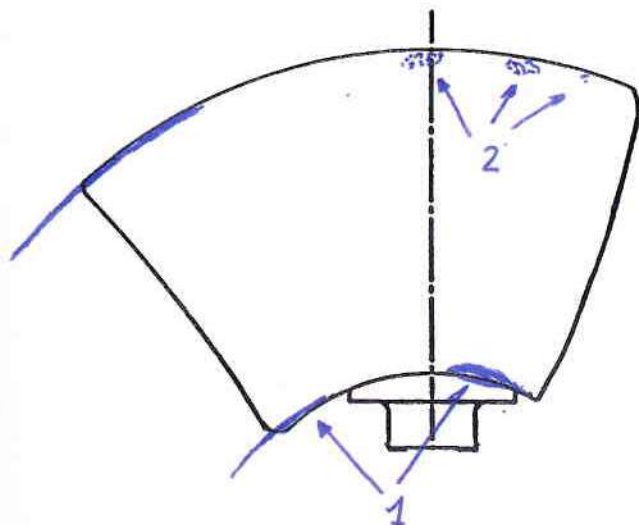
328-02-18 GABRIEL TERRA

NEYRPIC

Date:

04 AVR 92

$$\sigma = \underline{\underline{0.7854}}$$



Mesure: 45  
 $\alpha_p$  : 31.6°  
 $\gamma_d$  : 36.6 mm Hp : 16 m  
 Film : 2 Photo: 12

Commentaires:

1 : seulement sur les aubes 2, 3, 4 et 5

2 : intermittent.

Por OTE

pour EDF

pour IMHEF

pour IMHEF

pour NP

pour NP

pour EDF

pour IMHEF

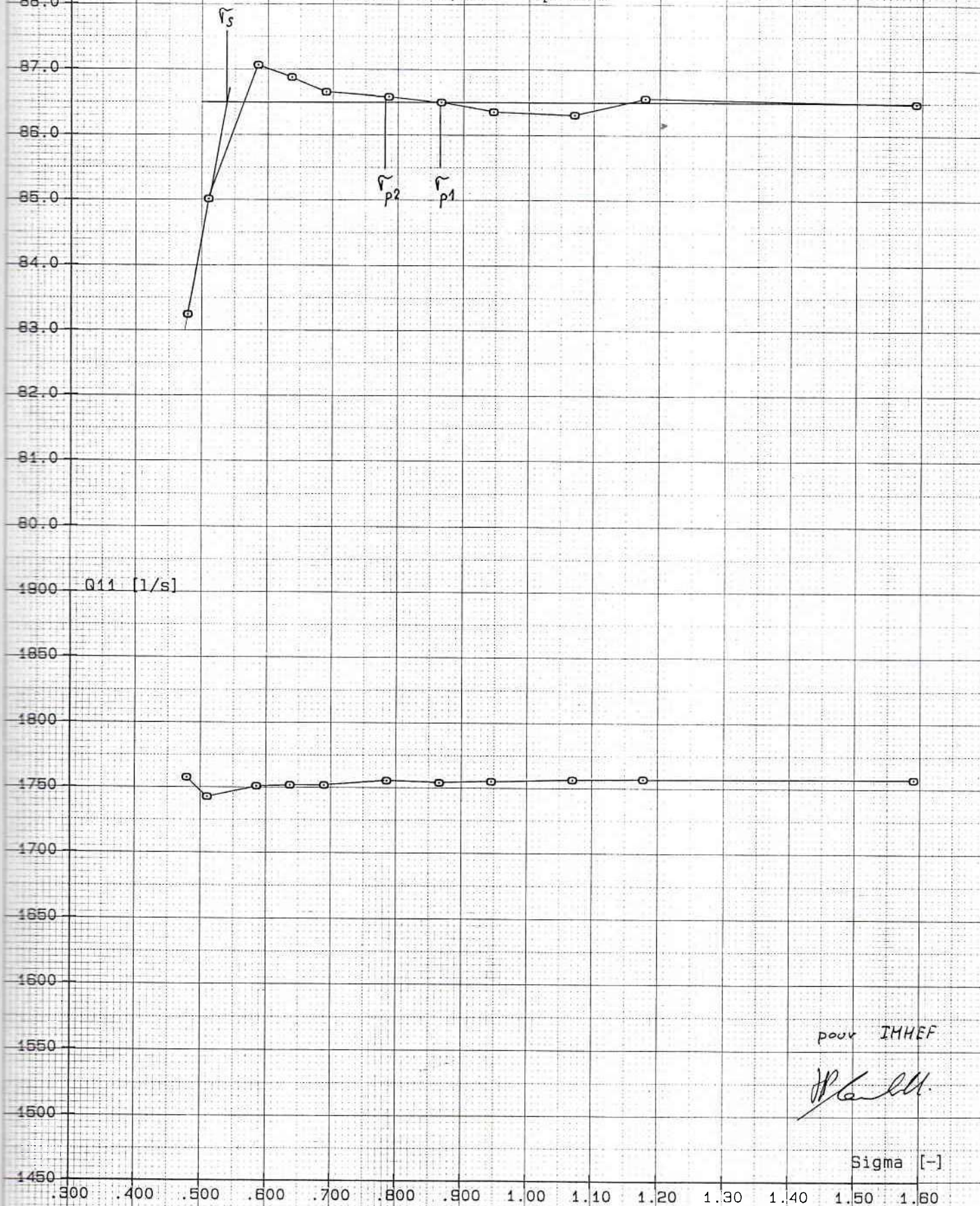
Cavitation

Roue : 5-KN-35

04 AVR 92

Eta [%] Alpha\_p=31.6 deg. Gamma\_d=36.6 mm.

n11= 151.5 t/min. Hp= 16 m





**328-03 .**

***EMBALAMIENTO***



# GABRIEL TERRA

## Essai d'emballlement du 06/04/92

Une colline d'emballlement hors cavitation a été établie; les inclinaisons de pale suivantes ont été étudiées:  $\alpha_p = 6^\circ - 16^\circ - 18^\circ - 29^\circ - 20^\circ - 24^\circ - 30^\circ - 36^\circ$ .

La valeur maximale de  $n_{11}$  emballlement = 271 tr/min confirme celle obtenue à Grenoble.

L'essai en cavitation a été effectué à la vitesse maximale hors cavitation ( $\alpha_p = 19^\circ - \gamma_d = 39.3$  mm).

Le  $n_{11}$  emballlement maximum maximorum obtenu est de  $n_{11e} = 298.2$  tr/min.

Il en résulte une vitesse d'emballlement maximum maximorum sur le prototype de:

$$\begin{aligned} n_{e\max i} &= 298.2 \cdot \sqrt{28} / 4.848 \\ &= 325.5 \cdot \text{tr/min} \end{aligned}$$

Les essais dans le laboratoire de l'IMHEF, Lausanne, montrent que la vitesse d'emballlement garantie de 330 tr/min ne sera pas atteinte.

Un deuxième point d'essai en cavitation a été demandé par le représentant d'EDF; il correspond au débit maximum (ouverture maximale du distributeur et l'inclinaison maximale de la pale:  $\gamma_d = 44.5$  mm,  $\alpha_p = 36^\circ$ ).

Il est à noter que les valeurs  $\alpha_p = 36^\circ$ ,  $\gamma_d = 44.5$  mm sont respectivement des valeurs maxima mécaniques de la pale et du distributeur, donc correspondent à des fonctionnements en surpuissance.

Lausanne, le 06/04/92

pour U.T.E.:

Mme Tomalino

  
M. Ferreno



pour EDF:

M. Fritsch



pour NP:

M. Vinh



pour IMHEF:

M. Mombelli



| 328-02<br>No 1 |           | Ensayo : Emballiment<br>Essai: Runner : 5-KN-35 |             |              |            | SIN CAUTION   |            |          |                |              |             |          |          |          |             | Fecha: 06 AVR 92<br>Date: |  |
|----------------|-----------|---|-------------|--------------|------------|---------------|------------|----------|----------------|--------------|-------------|----------|----------|----------|-------------|---------------------------|--|
| No             | αp<br>(°) | γd<br>(mm)                                      | V<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | η<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | φ<br>(-) | ψ<br>(-) | σ<br>(-) | Hs<br>(mCE) | Np<br>(t/min)             |  |
| 1.             | 24.0      | 29.9  | .3139       | 19.957       | -.21       | 873.2         | 16.83      | -.30     | 232.6          | 1523.8       | -.046       | .1593    | .1322    | 4.3295   | .784        | 258.3                     |  |
| 2.             | 24.0      | 35.1  | .3773       | 19.686       | .18        | 955.6         | 16.83      | .25      | 256.3          | 1844.0       | .045        | .1750    | .1099    | 4.3887   | .785        | 296.2                     |  |
| 3.             | 24.0      | 39.2  | .4181       | 19.889       | .33        | 996.5         | 16.84      | .42      | 265.9          | 2033.0       | .083        | .1859    | .1012    | 4.3456   | .782        | 322.2                     |  |
| 4.             | 24.0      | 42.7  | .4380       | 19.463       | -.27       | 997.6         | 16.86      | -.34     | 269.1          | 2152.9       | -.071       | .1946    | .0988    | 4.4411   | .781        | 334.2                     |  |
| 5.             | 24.0      | 44.5  | .4503       | 19.491       | .04        | 995.5         | 16.89      | .05      | 268.3          | 2212.0       | .011        | .2005    | .0994    | 4.4374   | .775        | 341.9                     |  |
| 6.             | 20.0      | 30.0  | .2956       | 19.905       | .36        | 932.8         | 16.86      | .60      | 248.8          | 1437.1       | .085        | .1405    | .1156    | 4.3403   | .785        | 247.3                     |  |
| 7.             | 20.0      | 35.2  | .3327       | 18.877       | .05        | 970.8         | 16.85      | .08      | 265.9          | 1660.7       | .013        | .1519    | .1012    | 4.5695   | .789        | 267.3                     |  |
| 8.             | 20.0      | 39.2  | .3607       | 19.321       | -.42       | 1000.7        | 16.85      | -.63     | 270.9          | 1779.7       | -.110       | .1597    | .0975    | 4.4704   | .787        | 285.3                     |  |
| 9.             | 20.0      | 42.7  | .3765       | 19.572       | -.42       | 1004.4        | 16.86      | -.60     | 270.2          | 1845.5       | -.109       | .1661    | .0980    | 4.4147   | .784        | 295.3                     |  |
| 10.            | 20.0      | 44.5  | .3885       | 19.799       | -.02       | 1009.8        | 16.86      | -.03     | 270.1          | 1893.5       | -.005       | .1705    | .0981    | 4.3588   | .784        | 303.2                     |  |
| 11.            | 30.1      | 30.0  | .3297       | 18.662       | .41        | 770.3         | 16.84      | .54      | 212.2          | 1654.9       | .088        | .1896    | .1589    | 4.6268   | .780        | 265.3                     |  |
| 12.            | 30.1      | 35.1  | .4023       | 18.521       | -.26       | 850.5         | 16.84      | -.31     | 235.2          | 2027.4       | -.061       | .2096    | .1293    | 4.6633   | .778        | 310.2                     |  |
| 13.            | 30.1      | 39.3  | .4584       | 18.177       | -.00       | 900.7         | 16.85      | -.01     | 251.4          | 2331.8       | -.001       | .2255    | .1132    | 4.7521   | .777        | 345.5                     |  |
| 14.            | 30.1      | 42.8  | .5121       | 19.210       | .49        | 951.8         | 16.87      | .50      | 258.4          | 2533.6       | .124        | .2384    | .1071    | 4.4997   | .770        | 381.8                     |  |
| 15.            | 30.1      | 44.5  | .5424       | 19.720       | -.42       | 975.5         | 16.90      | -.40     | 261.4          | 2648.9       | -.103       | .2464    | .1047    | 4.3864   | .764        | 402.3                     |  |
| 16.            | 36.0      | 30.0  | .3650       | 20.903       | .01        | 730.4         | 16.89      | .01      | 190.1          | 1731.2       | .001        | .2215    | .1980    | 4.1315   | .778        | 290.3                     |  |
| 17.            | 36.0      | 35.1  | .4290       | 18.772       | .21        | 770.7         | 16.90      | .21      | 211.7          | 2147.5       | .045        | .2467    | .1597    | 4.6026   | .774        | 327.2                     |  |
| 18.            | 36.0      | 39.4  | .5084       | 18.985       | .33        | 840.7         | 16.91      | .30      | 229.6          | 2530.4       | .074        | .2680    | .1357    | 4.5522   | .771        | 379.2                     |  |
| 19.            | 36.0      | 42.8  | .5669       | 19.040       | -.33       | 880.6         | 16.93      | -.28     | 240.1          | 2817.4       | -.077       | .2853    | .1241    | 4.5454   | .759        | 417.3                     |  |
| 20.            | 36.0      | 44.5  | .6163       | 20.154       | -.47       | 921.6         | 17.01      | -.36     | 244.3          | 2977.1       | -.106       | .2984    | .1199    | 4.3002   | .746        | 451.4                     |  |
| 21.            | 6.0       | 29.9  | .0903       | 19.210       | .23        | 705.5         | 16.83      | 1.00     | 191.5          | 446.7        | .044        | .0567    | .1950    | 4.4857   | .798        | 157.6                     |  |
| 22.            | 6.0       | 35.2  | .0928       | 19.315       | -.26       | 705.5         | 16.83      | -.109    | 191.0          | 458.1        | -.049       | .0583    | .1961    | 4.4614   | .798        | 159.2                     |  |
| 23.            | 6.0       | 39.2  | .0946       | 19.762       | -.15       | 704.2         | 16.81      | -.60     | 188.5          | 461.4        | -.027       | .0595    | .2013    | 4.3603   | .798        | 161.3                     |  |
| 24.            | 6.0       | 42.7  | .0960       | 19.822       | -.37       | 698.5         | 16.80      | -.43     | 186.7          | 467.7        | -.065       | .0609    | .2052    | 4.3423   | .798        | 162.3                     |  |
| 25.            | 6.0       | 44.5  | .0968       | 19.943       | -.11       | 694.3         | 16.79      | -.43     | 185.0          | 469.9        | -.020       | .0618    | .2090    | 4.3159   | .798        | 162.8                     |  |
| 26.            | 18.0      | 29.9  | .2586       | 18.527       | .16        | 928.7         | 16.76      | .33      | 256.7          | 1303.0       | .043        | .1234    | .1085    | 4.6497   | .791        | 230.4                     |  |
| 27.            | 18.0      | 35.3  | .3048       | 18.511       | .49        | 970.5         | 16.75      | .88      | 268.4          | 1536.2       | .133        | .1392    | .0993    | 4.6527   | .793        | 250.3                     |  |
| 28.            | 18.0      | 39.3  | .3281       | 19.152       | -.23       | 997.7         | 16.76      | -.38     | 271.3          | 1625.7       | -.061       | .1457    | .0972    | 4.4973   | .792        | 265.3                     |  |
| 29.            | 18.0      | 42.7  | .3433       | 19.694       | -.24       | 1005.8        | 16.76      | -.37     | 269.7          | 1677.5       | -.061       | .1512    | .0983    | 4.3794   | .793        | 275.3                     |  |
| 30.            | 18.0      | 44.5  | .3503       | 19.444       | -.28       | 1004.6        | 16.76      | -.43     | 271.1          | 1722.6       | -.073       | .1545    | .0973    | 4.4319   | .788        | 279.3                     |  |
| 31.            | 18.0      | 39.2  | .3284       | 19.182       | -.16       | 997.7         | 16.77      | -.26     | 271.1          | 1626.0       | -.041       | .1459    | .0973    | 4.4896   | .794        | 265.3                     |  |
| 32.            | 16.0      | 35.4  | .2789       | 18.516       | -.46       | 964.4         | 16.75      | -.90     | 266.7          | 1405.5       | -.124       | .1282    | .1006    | 4.6504   | .795        | 235.3                     |  |
| 33.            | 16.0      | 39.2  | .2952       | 19.027       | -.15       | 977.5         | 16.74      | .28      | 266.7          | 1467.7       | .041        | .1386    | .1018    | 4.5254   | .795        | 245.3                     |  |
| 34.            | 16.0      | 42.7  | .3088       | 19.657       | .17        | 987.6         | 16.74      | .29      | 265.1          | 1510.6       | .043        | .1386    | .1018    | 4.5254   | .792        | 254.3                     |  |
| 35.            | 16.0      | 44.5  | .3126       | 20.034       | -.01       | 980.4         | 16.74      | -.02     | 260.7          | 1514.4       | -.003       | .1413    | .1053    | 4.3011   | .789        | 257.3                     |  |
| 36.            | 16.0      | 30.1  | .2602       | 19.600       | .12        | 960.5         | 16.74      | .23      | 258.2          | 1274.4       | .029        | .1200    | .1073    | 4.3943   | .793        | 227.2                     |  |

GABRIEL TERRA

U.T.E.

GEC ALSTHOM NEYRPEC


 INSTITUT DE MACHINES HYDRAULIQUES  
 ET DE MECANIQUE DES FLUIDES  
 ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE



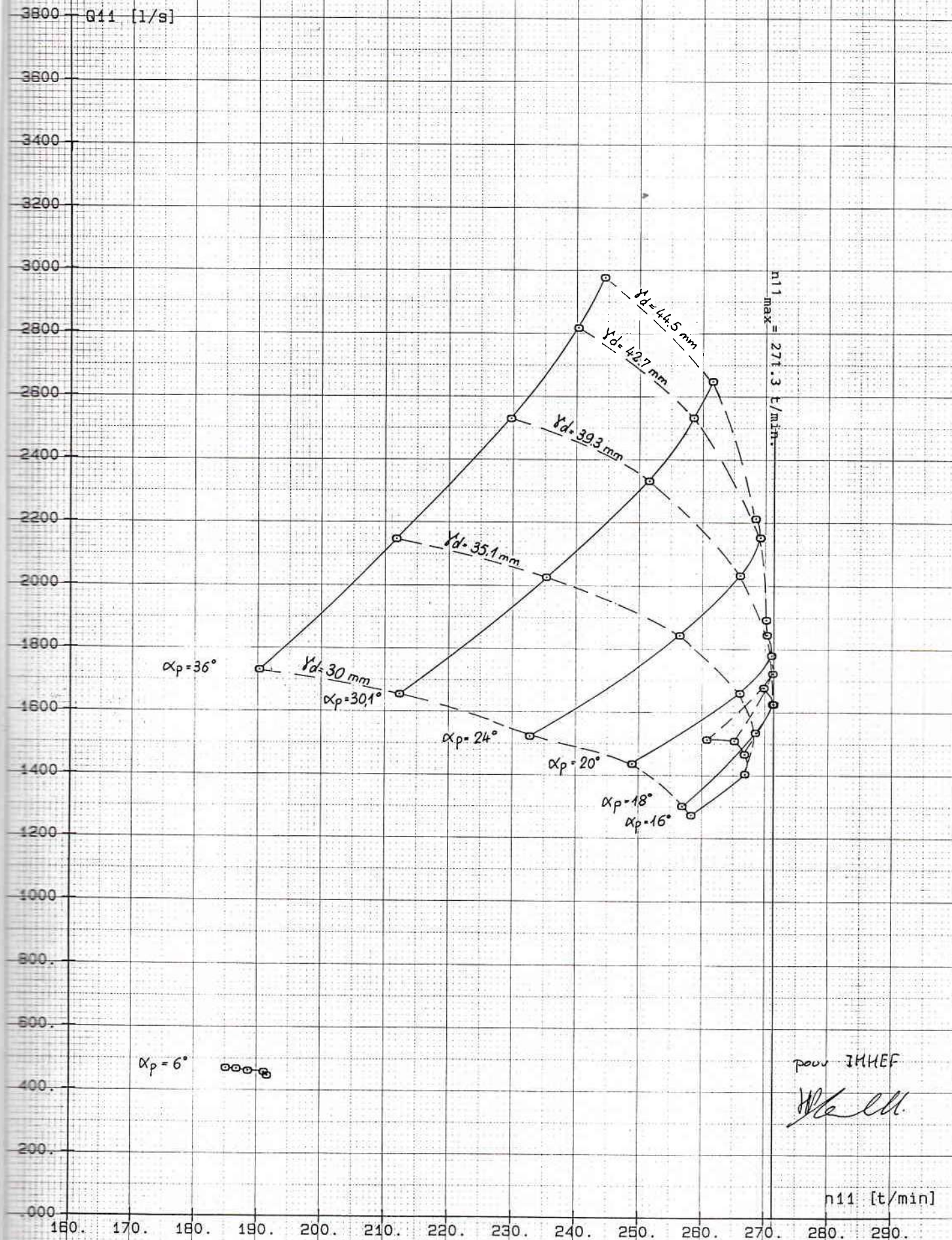







 UEL MAX  
 SIN CAUTION







| 328-02<br>No 03 |                   | Ensayo : Emballlement<br>Essai : Runner : 5-KN-35 |                     |              |            |               |            |               |                |              |             | Fecha: 06 AVR 92<br>Date: |               |  |             |               |
|-----------------|-------------------|---|---------------------|--------------|------------|---------------|------------|---------------|----------------|--------------|-------------|---------------------------|---------------|--|-------------|---------------|
| No              | $\alpha p$<br>(°) | $\gamma d$<br>(mm)                                | $\dot{V}$<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | $\eta$<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | $\varphi$<br>(-)          | $\psi$<br>(-) | $\sigma$<br>(-)  | Hs<br>(mCE) | Np<br>(t/min) |
| 37.             | 19.0              | 39.3  | .3299               | 19.722       | .08        | 998.6         | 16.72      | .13           | 267.6          | 1611.2       | .020        | .1464                     | .0999         | 4.3680   | .792        | 267.3         |
| 38.             | 19.0              | 39.3  | .3294               | 19.934       | .37        | 998.5         | 16.73      | .58           | 266.1          | 1599.8       | .092        | .1462                     | .1010         | 3.5091   | 2.443       | 267.0         |
| 39.             | 19.0              | 39.3  | .3292               | 19.475       | .29        | 998.4         | 16.73      | .48           | 269.2          | 1617.5       | .075        | .1461                     | .0987         | 2.4732   | 4.654       | 266.1         |
| 40.             | 19.0              | 39.3  | .3294               | 19.037       | -.46       | 998.4         | 16.73      | -.76          | 272.3          | 1637.2       | -.122       | .1462                     | .0965         | 2.0159   | 5.662       | 265.3         |
| 41.             | 19.0              | 39.3  | .3294               | 18.531       | -.47       | 1001.6        | 16.73      | -.81          | 276.9          | 1659.4       | -.131       | .1457                     | .0933         | 1.7001   | 6.363       | 264.3         |
| 42.             | 19.0              | 39.3  | .3299               | 18.141       | -.23       | 1007.2        | 16.72      | -.41          | 281.4          | 1679.7       | -.067       | .1452                     | .0904         | 1.4484   | 6.897       | 264.3         |
| 43.             | 19.0              | 39.3  | .3361               | 18.596       | -.49       | 1030.6        | 16.73      | -.85          | 284.4          | 1690.2       | -.141       | .1445                     | .0885         | 1.1680   | 7.361       | 268.3         |
| 44.             | 19.0              | 39.3  | .3748               | 23.055       | .41        | 1150.8        | 16.73      | .57           | 285.2          | 1692.8       | .094        | .1443                     | .0880         | .9328  | 7.373       | 299.2         |
| 45.             | 19.0              | 39.3  | .3928               | 24.489       | .16        | 1200.8        | 16.74      | .21           | 288.7          | 1721.5       | .035        | .1450                     | .0858         | .8757  | 7.379       | 312.2         |
| 46.             | 19.0              | 39.3  | .4101               | 25.934       | -.03       | 1250.7        | 16.75      | -.03          | 292.2          | 1746.4       | -.006       | .1453                     | .0838         | .8254  | 7.393       | 325.2         |
| 47.             | 19.0              | 39.3  | .4274               | 27.762       | -.32       | 1300.7        | 16.77      | -.37          | 293.8          | 1759.2       | -.063       | .1456                     | .0829         | .7621  | 7.408       | 338.1         |
| 48.             | 19.0              | 39.3  | .4441               | 29.828       | -.38       | 1351.1        | 16.78      | -.41          | 294.4          | 1763.3       | -.070       | .1457                     | .0826         | .7074  | 7.414       | 351.3         |
| 49.             | 19.0              | 39.3  | .4614               | 33.250       | .51        | 1400.8        | 16.80      | .49           | 289.1          | 1735.4       | .083        | .1460                     | .0856         | .6362  | 7.408       | 366.2         |
| 50.             | 19.0              | 39.3  | .4532               | 31.696       | .50        | 1375.8        | 16.83      | .51           | 290.8          | 1745.6       | .087        | .1460                     | .0846         | .6648  | 7.416       | 359.3         |
| 51.             | 36.0              | 44.5  | .5986               | 19.898       | .44        | 921.6         | 16.89      | .36           | 245.9          | 2910.4       | .103        | .2879                     | .1184         | 4.6990   | .030        | 439.3         |
| 52.             | 36.0              | 44.5  | .5991               | 19.825       | -.35       | 921.6         | 16.92      | -.28          | 246.3          | 2917.7       | -.081       | .2881                     | .1179         | 3.4903   | 2.508       | 439.3         |
| 53.             | 36.0              | 44.5  | .6001               | 19.572       | -.41       | 921.6         | 16.94      | -.34          | 247.9          | 2941.8       | -.098       | .2886                     | .1164         | 2.9867   | 3.602       | 439.3         |
| 54.             | 36.0              | 44.5  | .6001               | 19.187       | -.29       | 920.8         | 16.98      | -.25          | 250.2          | 2970.9       | -.071       | .2888                     | .1143         | 2.4101   | 4.848       | 439.3         |
| 55.             | 36.0              | 44.5  | .6039               | 19.034       | .04        | 920.8         | 17.01      | .04           | 251.2          | 3001.7       | .011        | .2906                     | .1134         | 1.9564   | 5.765       | 441.3         |
| 56.             | 36.0              | 44.5  | .6042               | 19.403       | -.16       | 921.5         | 17.05      | -.13          | 248.9          | 2974.5       | -.039       | .2906                     | .1155         | 1.5477   | 6.500       | 442.3         |
| 57.             | 36.0              | 44.5  | .6025               | 19.949       | .74        | 921.6         | 17.11      | .59           | 245.5          | 2925.2       | .170        | .2897                     | .1187         | 1.2522   | 7.014       | 441.4         |
| 58.             | 36.0              | 44.5  | .6068               | 25.545       | -.81       | 927.8         | 17.19      | -.51          | 218.4          | 2603.7       | -.129       | .2898                     | .1499         | .7320  | 7.654       | 450.3         |
| 59.             | 36.0              | 44.5  | .6130               | 24.429       | .69        | 935.9         | 17.23      | .45           | 225.3          | 2689.5       | .119        | .2903                     | .1409         | .8540  | 7.433       | 453.4         |
| GABRIEL TERRA   |                   | U.T.E.  |                     |              |            |               |            |               |                |              |             | GEC ALSTHOM NEYRPIC       |               |  <b>IMHEF</b><br>INSTITUT DE MACHINES HYDRAULIQUES<br>ET DE MÉCANIQUE DES FLUIDES<br>ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE |             |               |

GABRIEL TERRA

U.T.E.

GEC ALSTHOM NEYRPIC


 INSTITUT DE MACHINES HYDRAULIQUES  
 ET DE MECHANIQUE DES FLUIDES  
 ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE

 HALL  
 12

EDF

12

 VEC MAY  
 CON COM  
 HALL  
 VEC  
 CALUDA  
 HALL

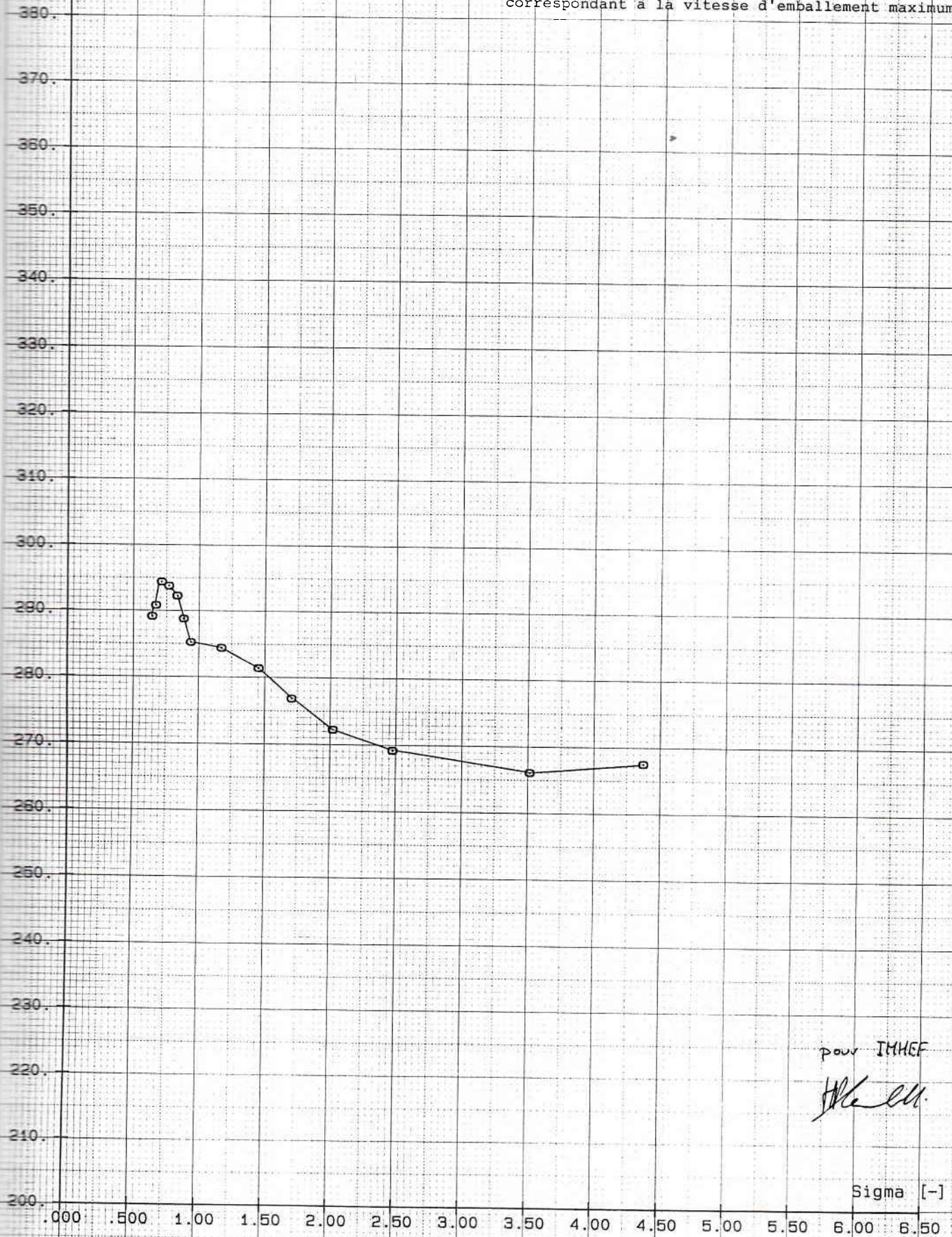
Emballlement

Roue : 5-KN-35

06 AVR 92

n11 [t/min]

$\alpha_p = 19.0 \text{ deg.}$   $\gamma_d = 39.3 \text{ mm.}$   
correspondant à la vitesse d'emballement maximum



pour IMHEF

*[Signature]*

Sigma [-]



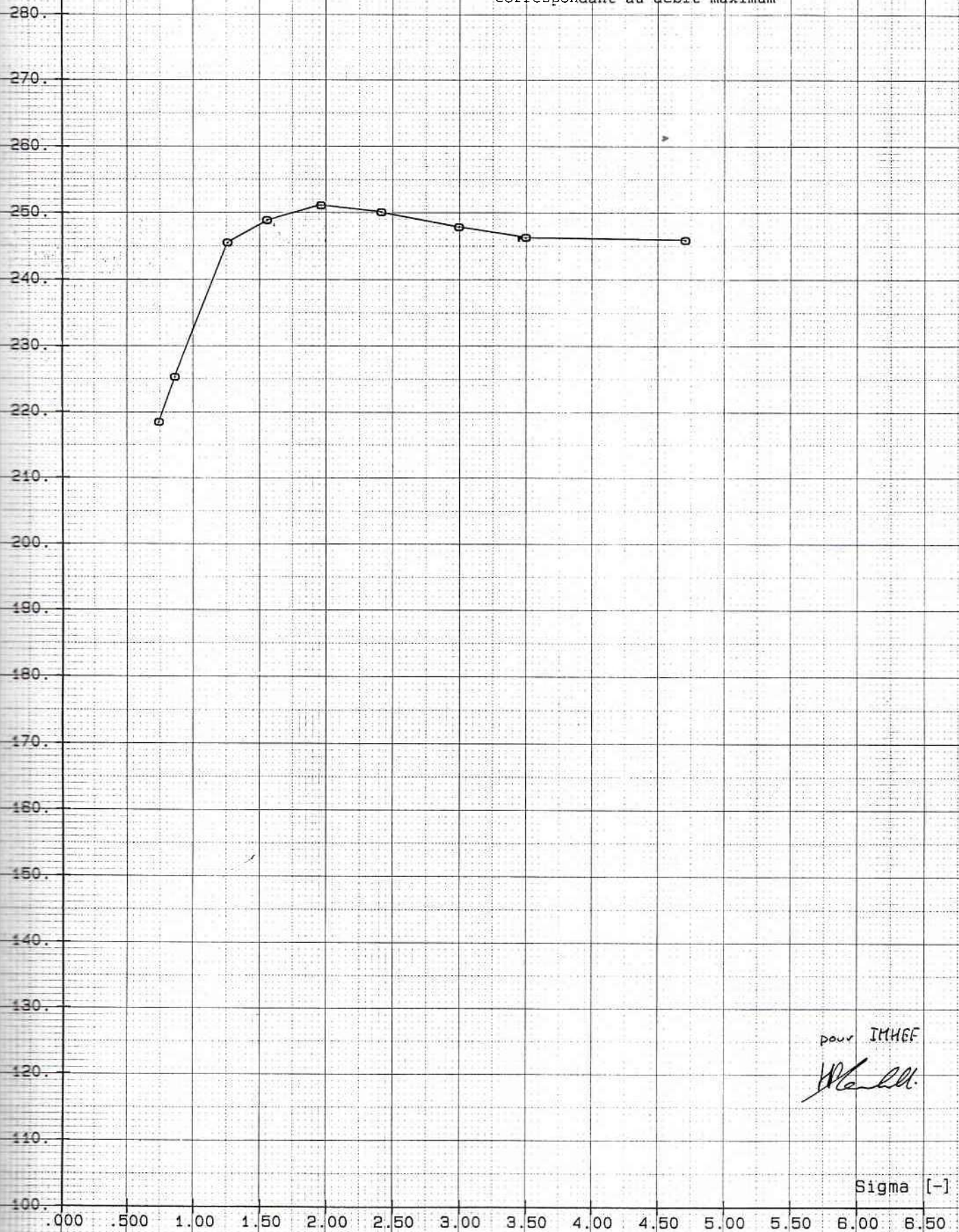
Emballlement

Roue : 5-KN-35

06 AVR 92

n11 [t/min]

$\alpha_p = 36.0 \text{ deg.}$      $\gamma_d = 44.5 \text{ mm.}$   
correspondant au débit maximum





**328-04 .**

***ESTABILIDAD  
DE  
FUNCIONAMIENTO***

# GABRIEL TERRA

## Mesures de fluctuation de pression du 07/04/92

Des capteurs ont été installés dans la section de mesure entrée bache (No 5) et dans le cône d'aspirateur (No 1, 2, 3, 4).

Des enregistrements et analyses spectrales ont été effectués aux fonctionnements suivants (cf tableau No 1328-04).

| $\alpha_p$ | $n_{11}$ |       |     |
|------------|----------|-------|-----|
| 30,1       | 121,2    | 132,2 | 147 |
| 24,1       | 121,2    | 132,2 | 147 |
| 18         | 121,2    | 132,2 | 147 |
| 6          | 121,2    | 132,2 | 147 |
| 34         | 121,2    | 132,2 | 147 |
| 12         | 121,2    | 132,2 | 147 |

L'inclinaison de pale  $\alpha_p = 6^\circ$  correspond à la valeur minimale sur la machine industrielle; celle de  $\alpha_p = 34^\circ$  correspond à une légère surpuissance sur la machine industrielle.

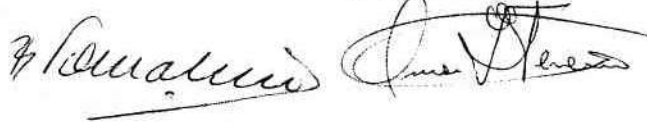
Dans la zone de fonctionnement en conjugaison avec garantie de rendement, l'amplitude maximale RMS de la fréquence prépondérante des fluctuations de l'écart de pression (bache - moyenne aspirateur) représente au maximum 0,3% de la chute nette.

Hors de cette zone de fonctionnement, notamment en surpuissance et à la puissance mini de 3 MW sous 17 mCE, ces mêmes fluctuations restent inférieures à 1% de la chute nette.

pour U.T.E.:

Mme Tomalino

M. Ferreño

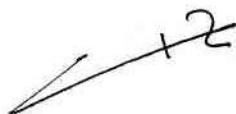


Les fluctuations de pressions mesurées sont faibles. Celles détectées dans le cône d'aspirateur sont souvent du même ordre de grandeur que celles détectées dans la bache.

Vis-à-vis des fluctuations de pression, la roue modèle est satisfaisante.

pour EDF:

M. Fritsch



pour NP:

M. Vinh



pour IMHEF:

M. Mombelli



Lausanne, le 07/04/92



| 328-04<br>No 1 |                   | Ensayo : Instabilites<br>Essai: Runner : 5-KN-35 |                     |              |            |               |            |               |                |              |             | Fecha : 07 Avr 92<br>Date: |               |                 |             |               |
|----------------|-------------------|--|---------------------|--------------|------------|---------------|------------|---------------|----------------|--------------|-------------|----------------------------|---------------|-----------------|-------------|---------------|
| No             | $\alpha_p$<br>(°) | $\gamma_d$<br>(mm)                               | $\dot{V}$<br>(m³/s) | gH<br>(J/Kg) | Ti<br>(Nm) | Nm<br>(t/min) | Te<br>(°C) | $\eta$<br>(%) | n11<br>(t/min) | Q11<br>(l/s) | P11<br>(kW) | $\varphi$<br>(-)           | $\psi$<br>(-) | $\sigma$<br>(-) | Hs<br>(mCE) | Np<br>(t/min) |
| 1.             | 30.1              | 30.0   | .4787               | 58.731       | 311.64     | 780.7         | 17.00      | 90.73         | 121.2          | 1354.7       | 12.038      | .2717                      | .4868         | .5593           | 6.182       | 407.3         |
| 2.             | 30.1              | 32.0   | .4897               | 56.121       | 285.96     | 832.5         | 17.21      | 90.84         | 132.2          | 1417.5       | 12.611      | .2607                      | .4090         | .6004           | 6.094       | 410.4         |
| 3.             | 30.1              | 35.0   | .5579               | 59.113       | 296.56     | 950.7         | 17.29      | 89.64         | 147.1          | 1573.6       | 13.815      | .2601                      | .3304         | .7449           | 5.039       | 453.9         |
| 4.             | 24.1              | 25.8   | .3609               | 58.740       | 236.80     | 780.4         | 17.29      | 91.39         | 121.2          | 1021.2       | 9.141       | .2050                      | .4873         | .4938           | 6.571       | 345.8         |
| 5.             | 24.1              | 28.0   | .3919               | 59.017       | 235.19     | 852.3         | 17.29      | 90.88         | 132.0          | 1106.2       | 9.846       | .2038                      | .4104         | .6047           | 5.890       | 361.3         |
| 6.             | 24.1              | 31.2   | .4377               | 59.101       | 232.66     | 950.8         | 17.29      | 89.66         | 147.2          | 1234.7       | 10.843      | .2040                      | .3303         | .7370           | 5.087       | 385.3         |
| 7.             | 18.0              | 20.3   | .2580               | 58.716       | 167.12     | 780.7         | 17.09      | 90.31         | 121.2          | 730.1        | 6.458       | .1464                      | .4867         | .5033           | 6.507       | 303.3         |
| 8.             | 18.0              | 22.2   | .2797               | 58.881       | 165.52     | 852.6         | 17.07      | 89.85         | 132.2          | 790.5        | 6.956       | .1454                      | .4092         | .6054           | 5.886       | 311.3         |
| 9.             | 18.0              | 24.4   | .3076               | 59.217       | 160.18     | 950.5         | 17.06      | 87.63         | 147.0          | 866.9        | 7.441       | .1434                      | .3311         | .7047           | 5.266       | 322.8         |
| 10.            | 6.0               | 8.4  | .0824               | 58.882       | 42.39      | 780.5         | 17.03      | 71.48         | 121.0          | 232.9        | 1.631       | .0468                      | .4884         | .4982           | 6.530       | 247.4         |
| 11.            | 6.0               | 9.3  | .0892               | 58.773       | 39.64      | 852.4         | 17.02      | 67.57         | 132.3          | 252.4        | 1.670       | .0464                      | .4087         | .6042           | 5.900       | 249.3         |
| 12.            | 6.0               | 10.5   | .1019               | 59.341       | 35.49      | 950.9         | 17.01      | 58.53         | 146.9          | 286.8        | 1.644       | .0475                      | .3316         | .7470           | 4.991       | 254.4         |
| 13.            | 6.0               | 4.9  | .0608               | 58.966       | 26.40      | 780.5         | 17.01      | 60.27         | 120.9          | 171.7        | 1.014       | .0345                      | .4891         | .5267           | 6.345       | 241.3         |
| 14.            | 34.0              | 33.7   | .5494               | 58.781       | 354.20     | 780.6         | 17.08      | 89.77         | 121.2          | 1553.9       | 13.663      | .3119                      | .4874         | .4971           | 6.531       | 448.3         |
| 15.            | 34.0              | 38.0   | .6220               | 58.798       | 361.08     | 852.8         | 17.21      | 88.29         | 132.3          | 1759.0       | 15.210      | .3232                      | .4084         | .6945           | 5.345       | 492.3         |
| 16.            | 34.0              | 40.7   | .6858               | 59.298       | 352.91     | 950.5         | 17.41      | 86.49         | 146.9          | 1931.3       | 16.360      | .3197                      | .3316         | .8578           | 4.321       | 532.3         |
| 17.            | 12.1              | 15.4   | .1768               | 58.542       | 109.42     | 780.8         | 17.47      | 86.54         | 121.4          | 501.2        | 4.248       | .1004                      | .4851         | .4984           | 6.521       | 282.4         |
| 18.            | 12.1              | 17.1   | .1918               | 58.871       | 108.75     | 852.3         | 17.45      | 86.09         | 132.2          | 542.0        | 4.570       | .0997                      | .4094         | .6005           | 5.891       | 288.1         |
| 19.            | 12.1              | 18.8   | .2099               | 59.189       | 103.46     | 950.6         | 17.42      | 83.01         | 147.0          | 591.6        | 4.810       | .0978                      | .3309         | .7369           | 5.049       | 292.3         |
| pour EDF       |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
| f2             |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |
|                |                   |  |                     |              |            |               |            |               |                |              |             |                            |               |                 |             |               |

| Zoom   |    | Curseur |     | du1: gte001. ffb |  | 50. |  | mV FS  |  |
|--------|----|---------|-----|------------------|--|-----|--|--------|--|
|        |    |         |     | trace No 1.      |  | 5.  |  | mV/div |  |
| Zoom < | f. | Hz      | RMS | 64.453           |  |     |  |        |  |
| Zoom > | 1. | mV      | RMS | 17.185           |  |     |  |        |  |
| Zoom * | 2. | mV      | RMS | 16.931           |  |     |  |        |  |
| Zoom y | 3. | mV      | RMS | 123.57           |  |     |  |        |  |
| Cursor | 4. | mV      | RMS | 22.948           |  |     |  |        |  |
|        | 5. | mV      | RMS | 81.298           |  |     |  |        |  |
|        | 6. | mV      | RMS | 11.352           |  |     |  |        |  |
|        |    | mV      | RMS | -35.112          |  |     |  |        |  |
|        |    | mV      | RMS | 8.8059           |  |     |  |        |  |
|        |    | mV      | RMS | -75.805          |  |     |  |        |  |
|        |    | mV      | RMS | 18.596           |  |     |  |        |  |
|        |    | mV      | RMS | -47.867          |  |     |  |        |  |

Trace *Helen*

Autre

Arrêt

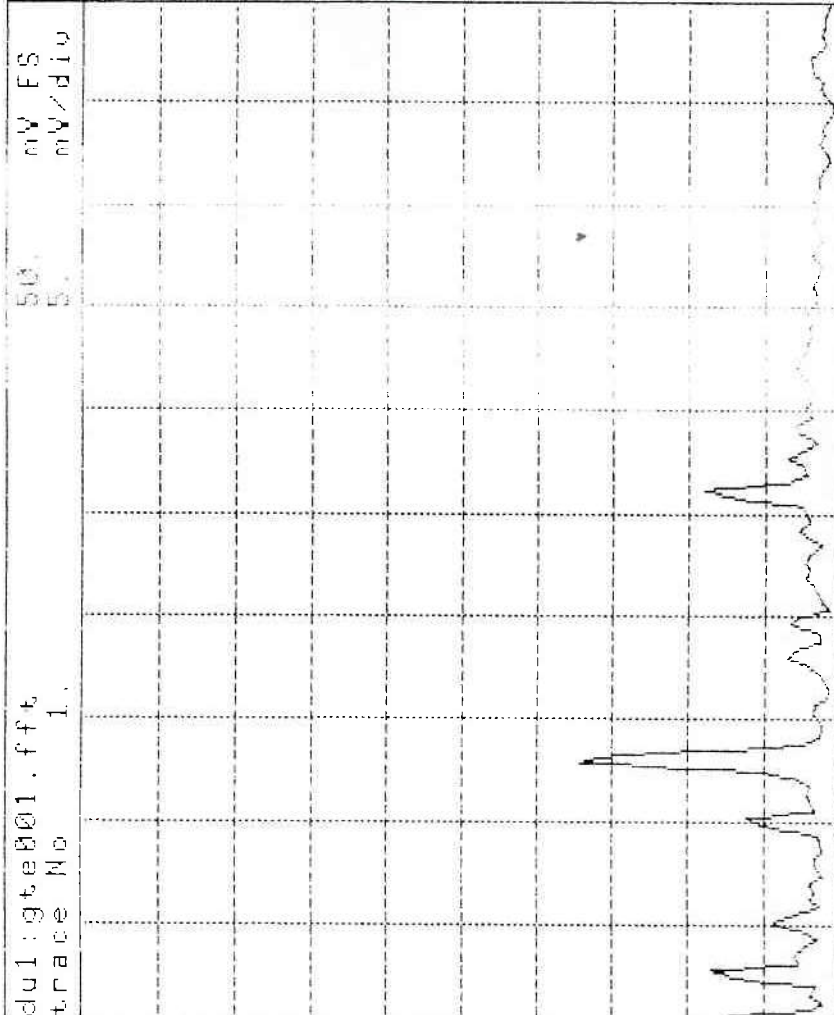
Grille

0.

25. Hz/div

125.

250.



Zoom X

II

১০০  
 ১০০  
 ১০০  
 ১০০  
 ১০০  
 ১০০

Zoom

1807

|   |    |    |
|---|----|----|
| 1 | 00 | 00 |
| 4 | 05 | 00 |
| 5 | 05 | 05 |
| 4 | .  | 05 |
| 1 | 00 | .  |
| 5 | 05 | 05 |

NON

— F E T I C —

— U P M C —

|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|

200m

5. Y. R. M. S.

ॐ  
 ॐ  
 म सु  
 म सु  
 . .  
 य न  
 न ॥

CONFIDENTIAL

TRAIL

104.71

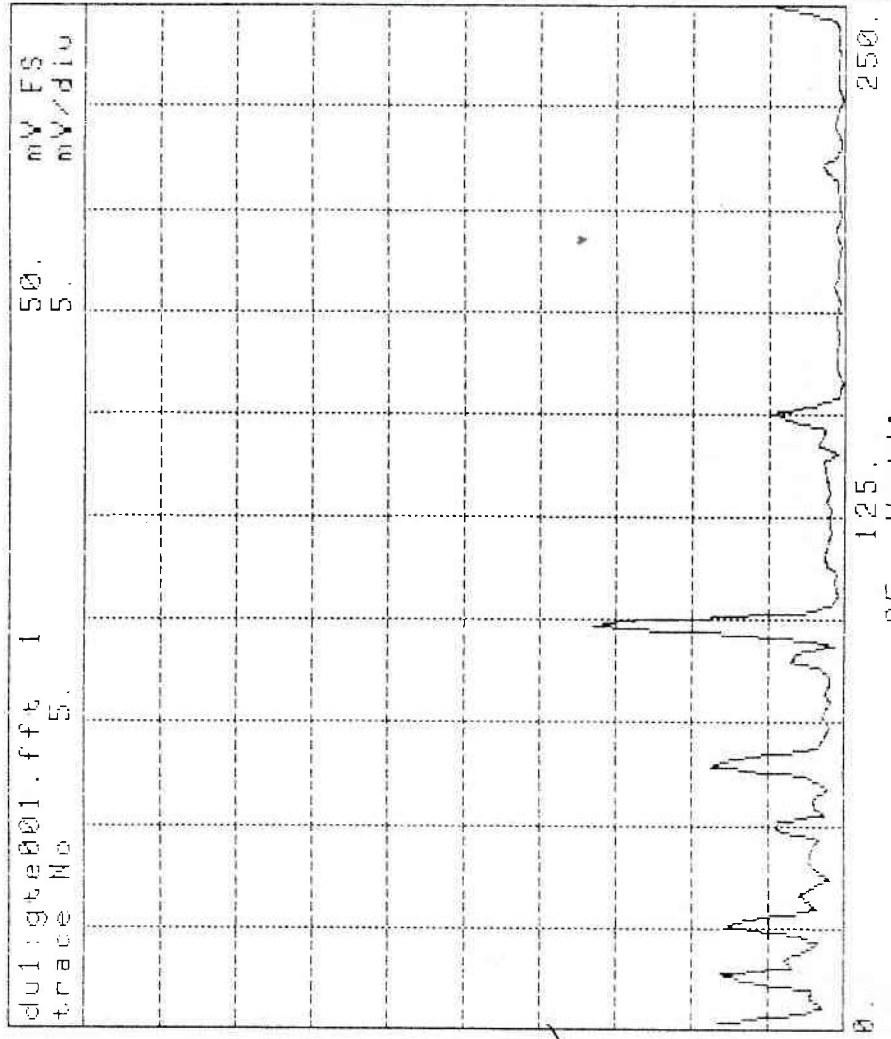
1. 1. 1. 1.

W. L. L.

五、六、七、八、九

100

Grillé



Taper le code du point pour enregistrer ou zero



NON

ΕΘΝ

2008

2000

10517

1000

11  
 12  
 13  
 14  
 15

Heidi

Figure 1

W. L. L.

~~27~~ June

*S. Prud'homme*

20. 012  
14. 052  
17. 025  
124. 222  
14. 782  
164. 333  
3. 8089  
-5. 519  
3. 2293  
135. 93  
14. 171  
90. 502

| du1:gte002.f fe | 50. | mV ES  |
|-----------------|-----|--------|
| trace No.       | 1.  | mV/div |
|                 |     |        |

50. my ES  
51. my dia

15/11/2019

259.

125. Hz/div

Taper le code du point pour enregistrer ou zero

2008

Zoom

NON

2000

10511

五  
四  
三  
二  
一

1945

Hrret

iii

21055-2110

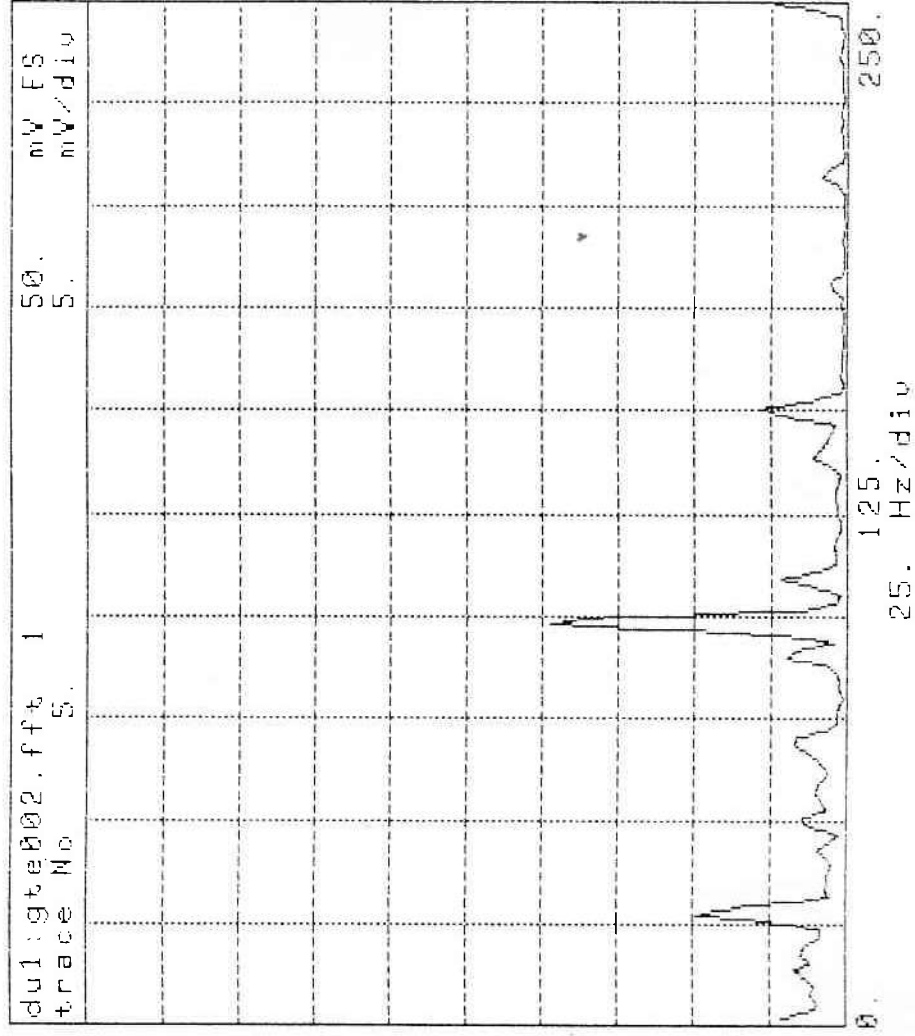
[illegible]

W. L. L.

✓ + 2 Spade

W. Lloyd Garrison

*[Handwritten signature]*



200m V

200m 3

NON

2003

205 JAN 7

1000

117

421

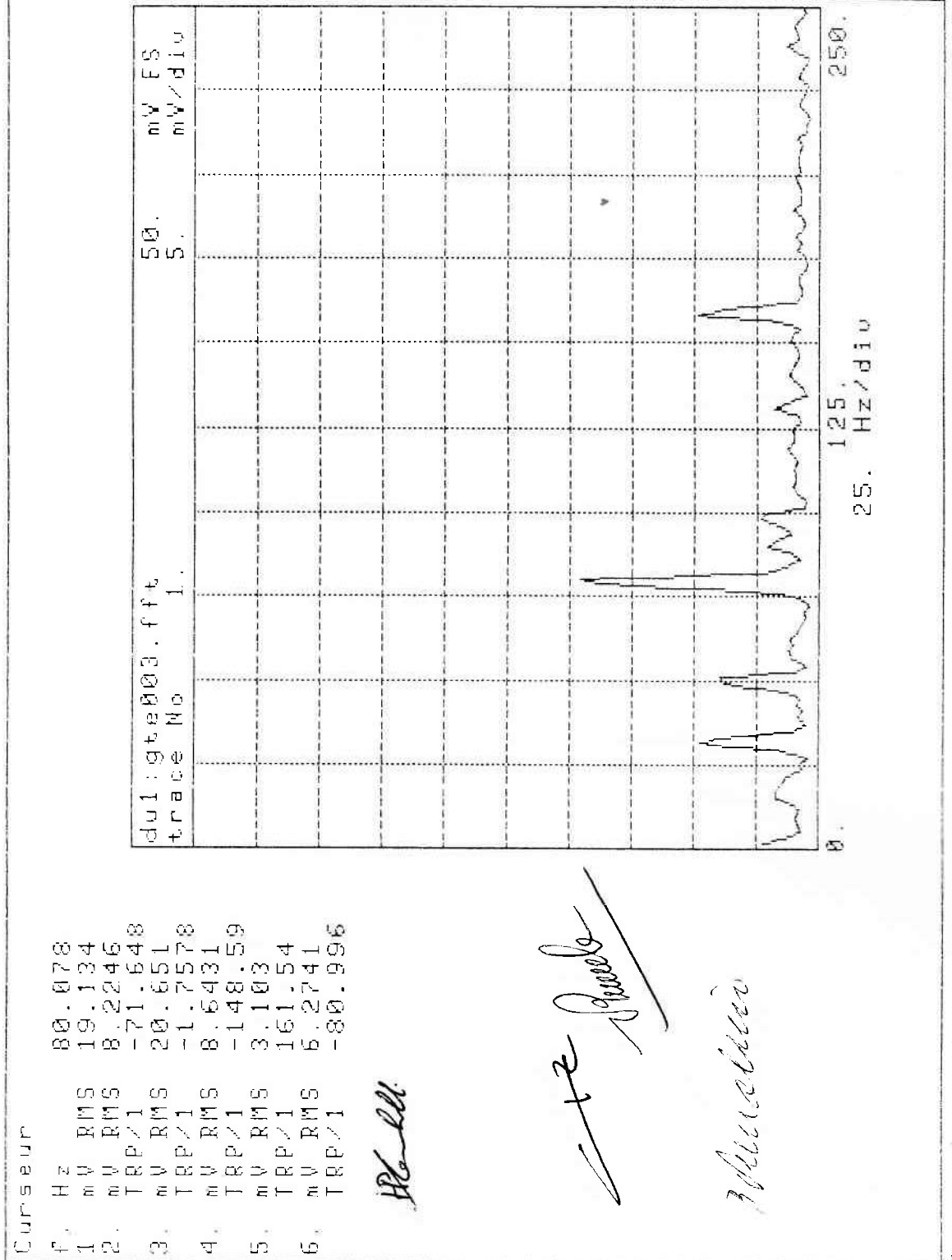
Fig. 1

|     |       |          |         |
|-----|-------|----------|---------|
| 1.  | $H^2$ |          | 80.073  |
| 2.  | $wv$  | RMS      | 19.134  |
| 3.  | $wv$  | RMS      | 8.2246  |
| 4.  | TRP   | $\chi^2$ | -71.648 |
| 5.  | $wv$  | RMS      | 20.651  |
| 6.  | TRP   | $\chi^2$ | -1.7578 |
| 7.  | $wv$  | RMS      | 8.6431  |
| 8.  | TRP   | $\chi^2$ | -148.59 |
| 9.  | $wv$  | RMS      | 3.103   |
| 10. | TRP   | $\chi^2$ | 161.54  |
| 11. | $wv$  | RMS      | 5.2741  |
| 12. | TRP   | $\chi^2$ | -80.996 |

H. C. C. C.

12 June

*Buller's*



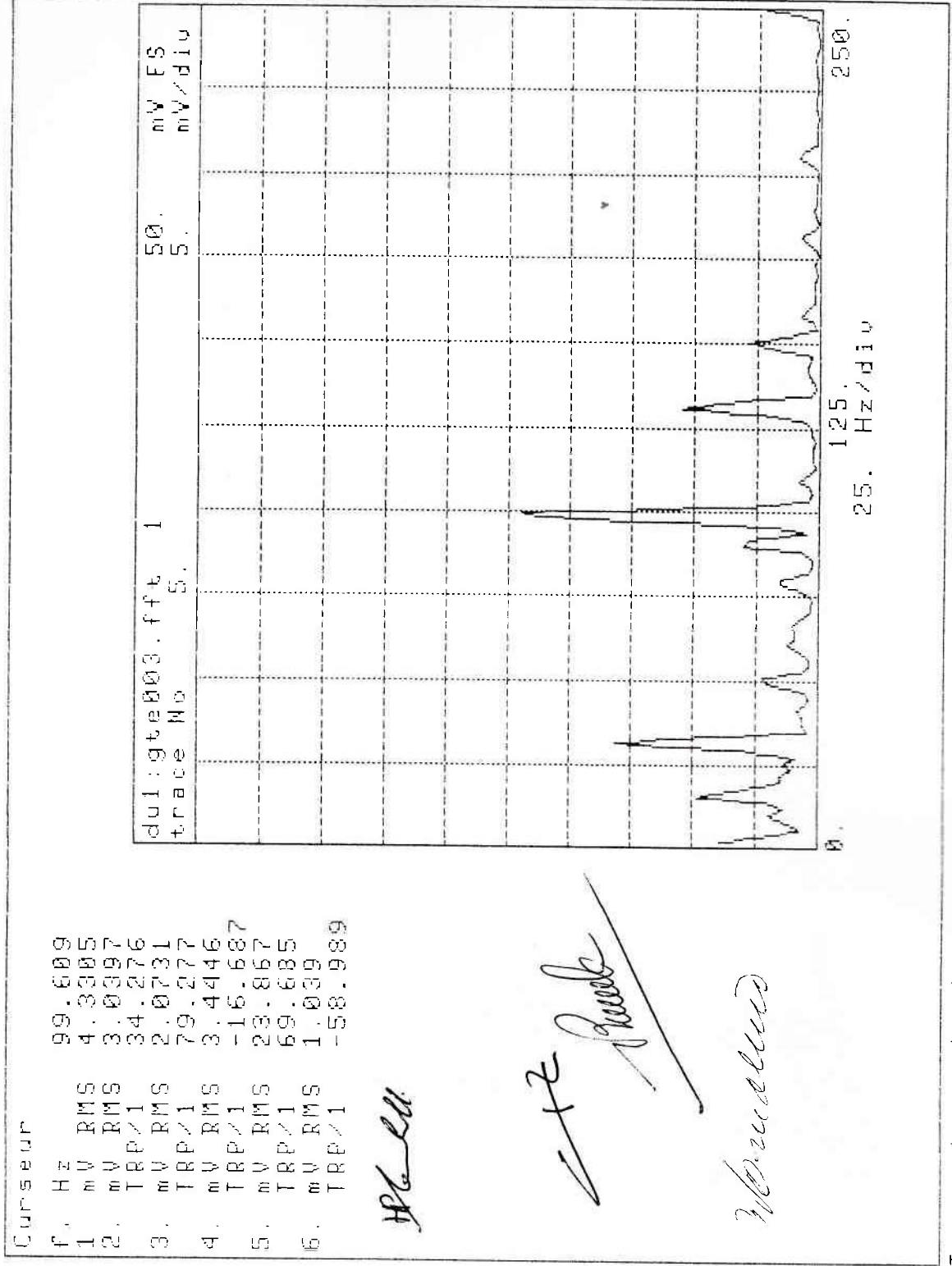


|                |         |         |  |  |  |
|----------------|---------|---------|--|--|--|
| F <sub>1</sub> | H F     |         |  |  |  |
| 1.             | mV RMS  | 99.609  |  |  |  |
| 2.             | mV RMS  | 4.3085  |  |  |  |
| 3.             | TRE / 1 | 3.0097  |  |  |  |
| 4.             | mV RMS  | 34.276  |  |  |  |
| 5.             | TRE / 1 | 2.0731  |  |  |  |
| 6.             | mV RMS  | 79.277  |  |  |  |
|                | TRE / 1 | 3.4446  |  |  |  |
|                | mV RMS  | -15.687 |  |  |  |
|                | TRE / 1 | 23.867  |  |  |  |
|                | mV RMS  | 59.685  |  |  |  |
|                | TRE / 1 | 1.039   |  |  |  |
|                | mV RMS  | -58.939 |  |  |  |

W. C. C. C.

✓ + 2 Good

2/10/22. 1914



Taper le code du point pour enregistrer ou zéro

Zoom

| f <sub>0</sub> | Hz     | mV RMS | TRP/1  | mV RMS | TRP/1  | mV RMS | TRP/1   |
|----------------|--------|--------|--------|--------|--------|--------|---------|
| 1.             | 54.453 | 5.0019 | 1.1881 | 88.501 | 137.64 | 1.7193 | 150.318 |
| 2.             |        |        |        |        |        |        |         |
| 3.             |        |        |        |        |        |        |         |
| 4.             |        |        |        |        |        |        |         |
| 5.             |        |        |        |        |        |        |         |
| 6.             |        |        |        |        |        |        |         |

Zoom

Zoom

2000

CURSOR

100-100000

五、六、七、八、九

٢٥٢١

11111

Ho. L.L.

*Handwritten signature*

*P. Buchner*

| du1:gate004.fft | mV ES  |
|-----------------|--------|
| trace No        | mV/div |
| 1.              | 50.    |
|                 | 5.     |

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|

10/15/11

259.

25. HZ/Div

15

Taper le code du point pour enregistrer au zero

Zoom

3002

三〇

ΣΟΦΟΝ

055 Jm

1000

五、

THE  
L  
L  
L  
L

Figure 1

Arasari

|     |                |     |  |  |  |        |
|-----|----------------|-----|--|--|--|--------|
| 1.  | H <sub>2</sub> |     |  |  |  | 10.567 |
| 2.  | wV             | RMS |  |  |  | 10.569 |
| 3.  | wV             | RMS |  |  |  | 10.574 |
| 4.  | TR             | PI  |  |  |  | 10.574 |
| 5.  | wV             | RMS |  |  |  | 10.577 |
| 6.  | TR             | PI  |  |  |  | 10.583 |
| 7.  | wV             | RMS |  |  |  | 10.585 |
| 8.  | TR             | PI  |  |  |  | 10.585 |
| 9.  | wV             | RMS |  |  |  | 10.587 |
| 10. | TR             | PI  |  |  |  | 10.591 |
| 11. | wV             | RMS |  |  |  | 10.593 |
| 12. | TR             | PI  |  |  |  | 10.599 |

W. C. C. M.

*Handwritten signature*

Wm. H. Burrows



Zoom X  
Zoom Y  
Zoom Z  
Zoom W  
Cursor

f.  
1.  
2.  
3.  
4.  
5.  
6.

Hz  
RMS  
RMS  
RMS  
RMS  
RMS  
RMS

70.312  
5.7545  
5.1936  
128.2  
7.044  
75.326  
3.5542  
-116.79  
2.3446  
99.874  
10.741  
-131.46

Trace  
Autre  
Arrêt  
Grille

*W. all.*  
  
*12*  
*W. all.*  
*W. all.*

du1:gte005.fff  
trace No

50.  
5.

mV FS  
mV/div

0.  
125.  
25. Hz/div

250.

Taper le code du point pour enregistrer ou zero



Zoom <  
Zoom >  
Zoom \*  
Zoom 0  
Cursor  
Trace  
Autre  
Arrêt  
Grille

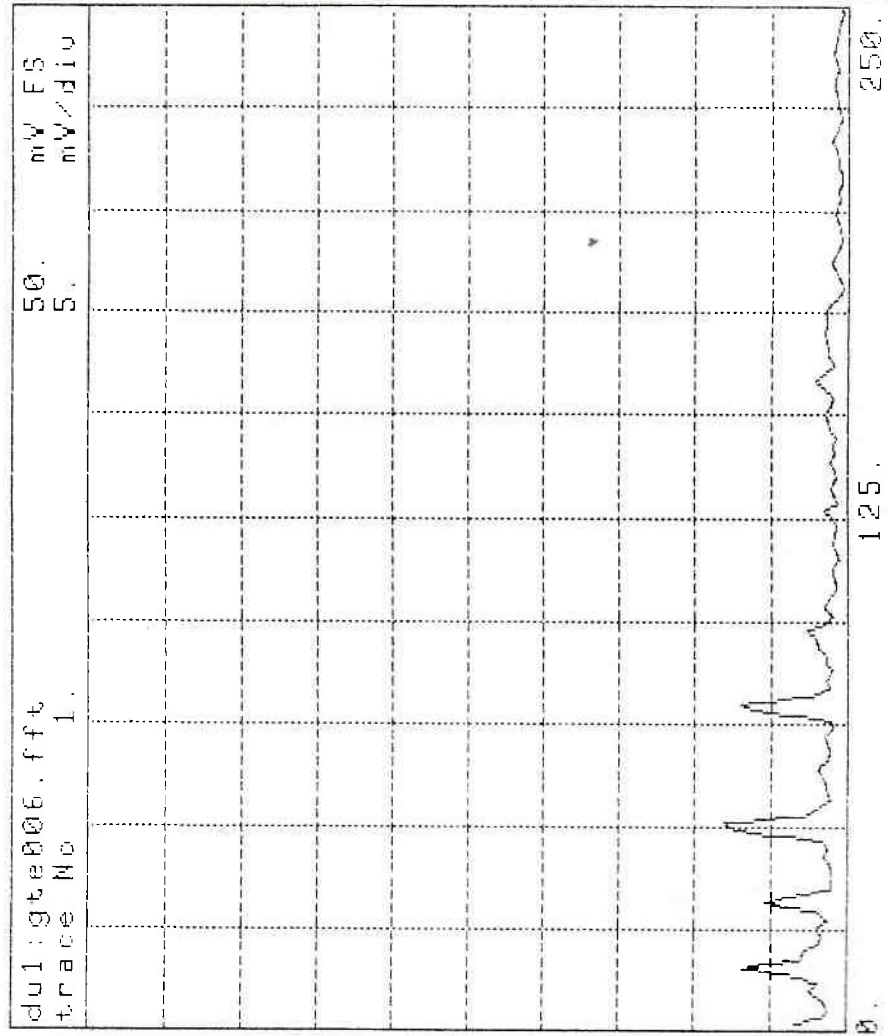
Curseur

1. Hz 80.078  
2. mV RMS 7.0044  
3. mV RMS 4.4977  
4. TRP/1 126.13  
5. mV RMS 7.5498  
6. TRP/1 -164.68  
7. mV RMS 4.6105  
8. TRP/1 -66.658  
9. mV RMS 0.93725  
10. TRP/1 162.67  
11. mV RMS 4.3652  
12. TRP/1 -117.

*St. M.*

*12*  
*St. M.*

*St. M.*  
*St. M.*





| Zoom   | Curseur | F. | Hz  | mV    | RMS    | 31.25  | 5.4397 | 6.6113 | 32.789  | 5.1459 | -12.955 | 7.6247 | 3.0932 | 12.481 | 49.089  | 1.825 | -40.893 |
|--------|---------|----|-----|-------|--------|--------|--------|--------|---------|--------|---------|--------|--------|--------|---------|-------|---------|
| Zoom < | 1.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Zoom > | 2.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Zoom * | 3.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Zoom v | 4.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Cursor | 5.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Trace  | 6.      | mV | RMS | 31.25 | 5.4397 | 6.6113 | 32.789 | 5.1459 | -12.955 | 7.6247 | 3.0932  | 12.481 | 49.089 | 1.825  | -40.893 |       |         |
| Autre  |         |    |     |       |        |        |        |        |         |        |         |        |        |        |         |       |         |
| Arrêt  |         |    |     |       |        |        |        |        |         |        |         |        |        |        |         |       |         |
| Grille |         |    |     |       |        |        |        |        |         |        |         |        |        |        |         |       |         |

du1: gte006. ffb 1

trace No 5.

50.

5.

mV FS

mV/div

0.

125.

25. Hz/div

250.

*Handwritten signature*

*Handwritten signature*

*Handwritten signature*

Zoom < 64.453  
 Zoom > 4.7023  
 Zoom \* 3.439  
 Zoom v 79.253  
 Cursor 4.3208  
 139.74  
 2.0114  
 -33.447  
 4.286  
 109.42  
 5.803  
 -109.52

W. H. H.

12. J. J. J.

3/11/11

J. J. J.

Curseur

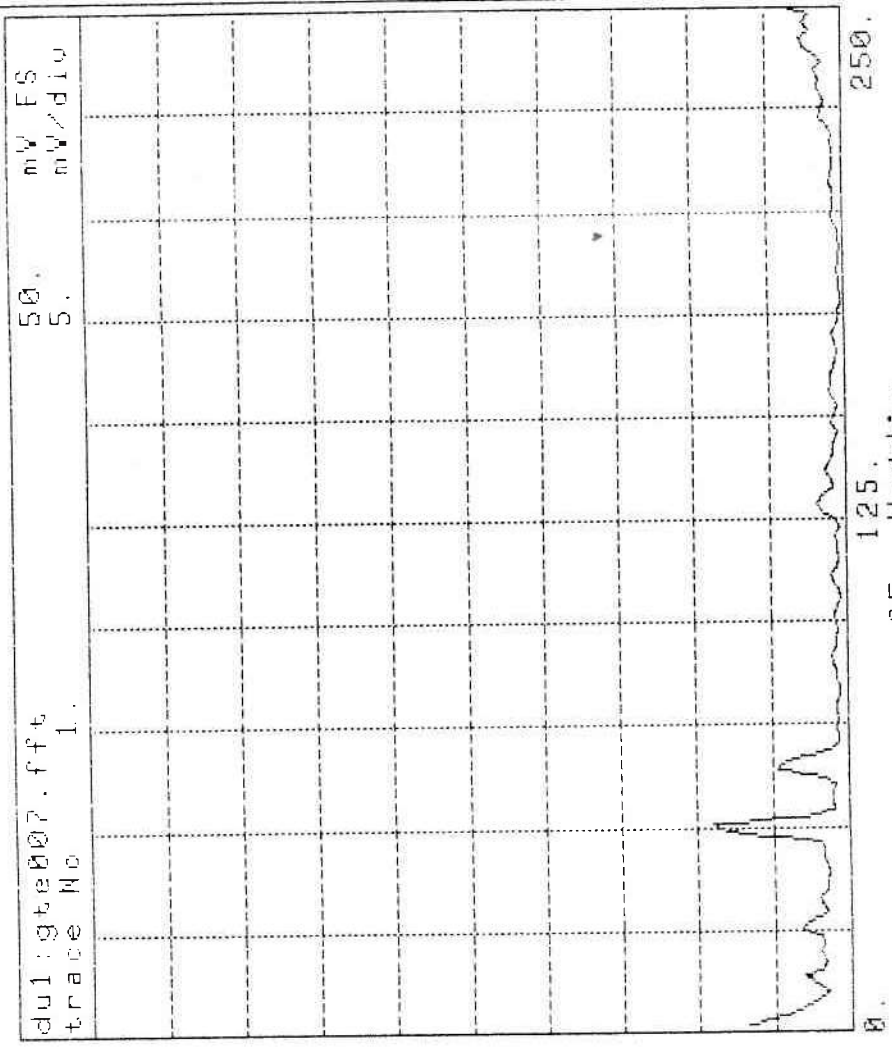
1. Hz 64.453  
 2. mV RMS 4.7023  
 3. TRP/1 3.439  
 4. mV RMS 79.253  
 5. TRP/1 4.3208  
 6. mV RMS 139.74  
 TRP/1 2.0114  
 mV RMS -33.447  
 TRP/1 4.286  
 mV RMS 109.42  
 TRP/1 5.803  
 mV RMS -109.52

Trace

Autre

Arrêt

Grille



Taper le code du point pour enregistrer au zero

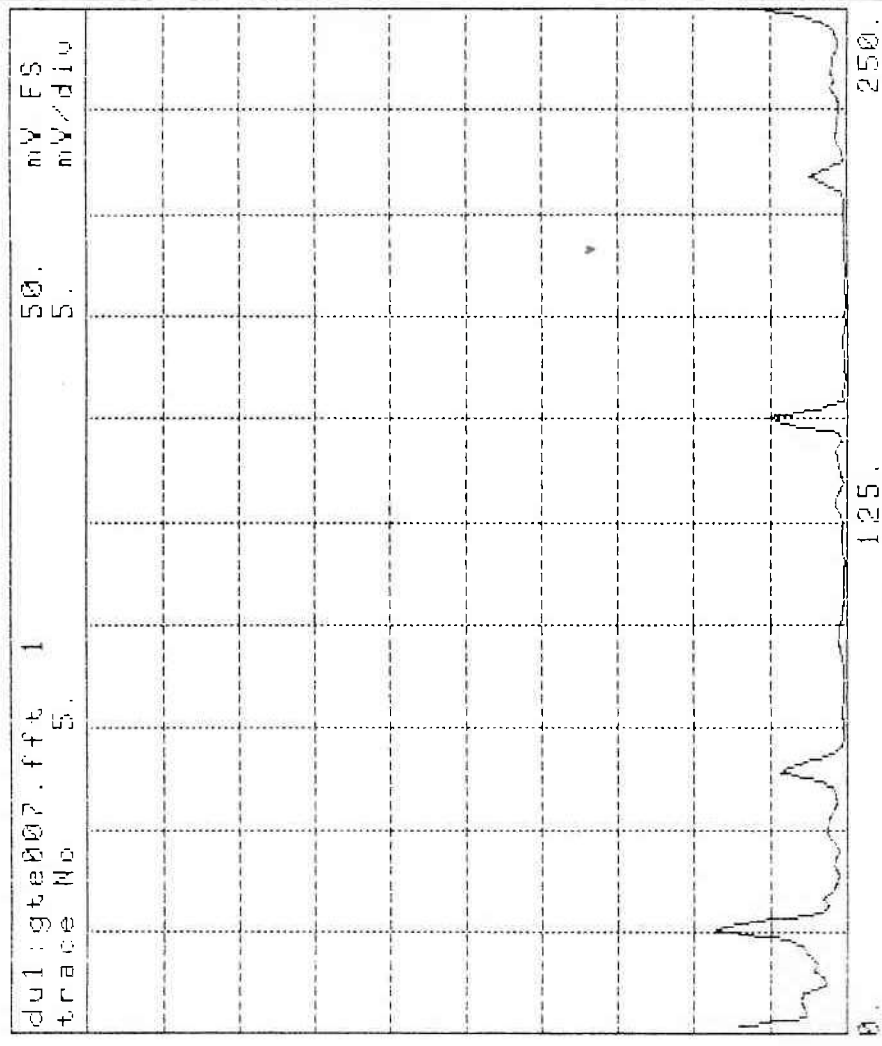
[illegible]

|    |    |     |
|----|----|-----|
| 11 | 12 | 13  |
| 14 | 15 | 16  |
| 17 | 18 | 19  |
| 20 | 21 | 22  |
| 23 | 24 | 25  |
| 26 | 27 | 28  |
| 29 | 30 | 31  |
| 32 | 33 | 34  |
| 35 | 36 | 37  |
| 38 | 39 | 40  |
| 41 | 42 | 43  |
| 44 | 45 | 46  |
| 47 | 48 | 49  |
| 50 | 51 | 52  |
| 53 | 54 | 55  |
| 56 | 57 | 58  |
| 59 | 60 | 61  |
| 62 | 63 | 64  |
| 65 | 66 | 67  |
| 68 | 69 | 70  |
| 71 | 72 | 73  |
| 74 | 75 | 76  |
| 77 | 78 | 79  |
| 80 | 81 | 82  |
| 83 | 84 | 85  |
| 86 | 87 | 88  |
| 89 | 90 | 91  |
| 92 | 93 | 94  |
| 95 | 96 | 97  |
| 98 | 99 | 100 |

212 Book

W. D. L. L. L.

Ende Luther



Taper le code du point pour enregistrer ou zéro



Zoom < 27.344  
 1. Hz RMS 6.2967  
 2. mV RMS 6.2363  
 3. TRP/1 14.581  
 4. mV RMS 4.3856  
 5. TRP/1 -8.1062  
 6. mV RMS 5.5193  
 7. TRP/1 -5.7049  
 8. mV RMS 11.438  
 9. TRP/1 80.689  
 10. mV RMS 0.46152  
 11. TRP/1 116.27

Trace *W. L. L.*

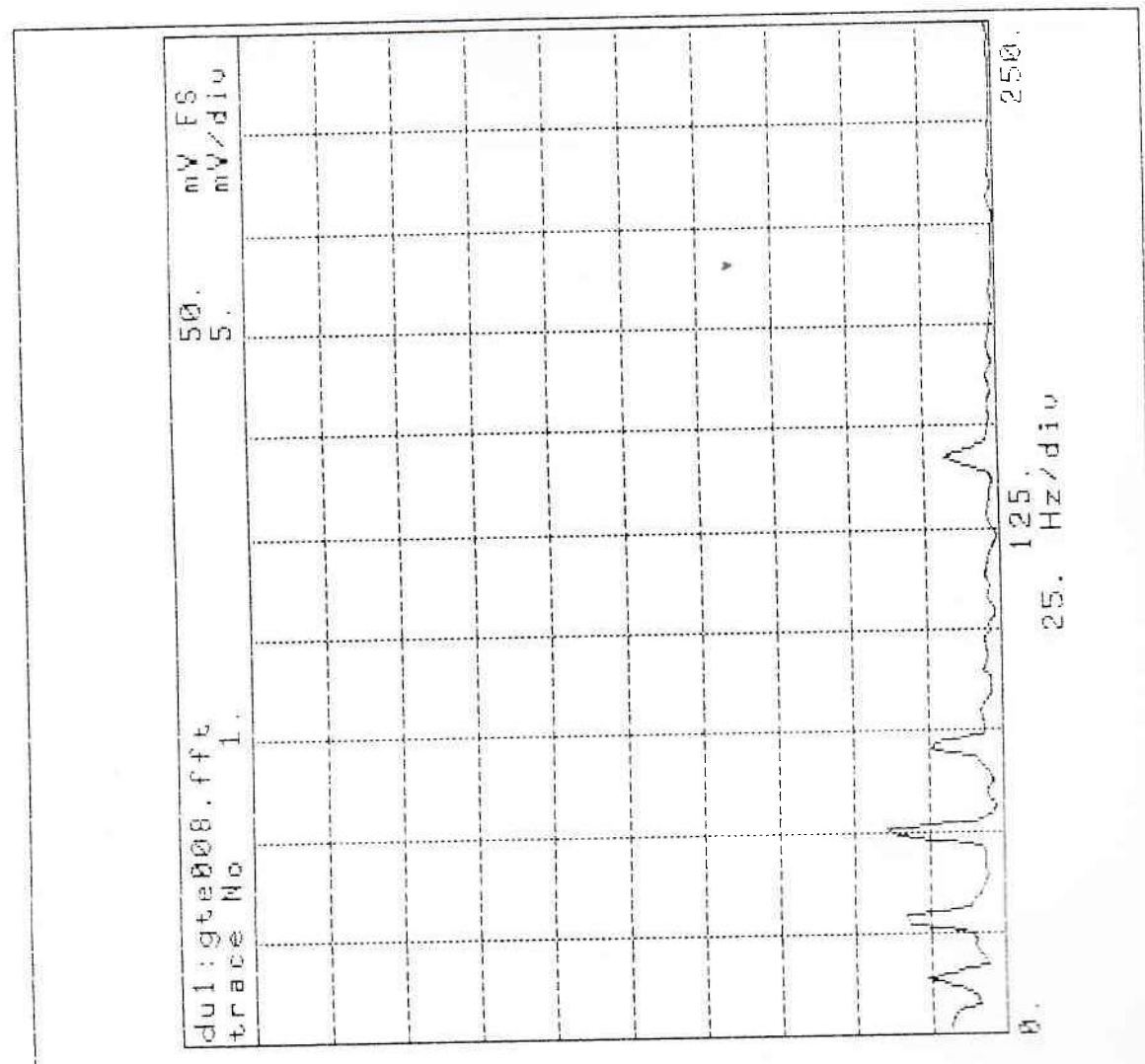
Autre

Arrêt

Grille

*✓* *Quelle*

*W. L. L.*  
*Quelle*



Zoom <

f. Hz 80.078

Zoom >

1. mV RMS 5.3887

Zoom \*

2. mV RMS 3.8483

Zoom v

3. TRP/1 100.32

Cursor

4. mV RMS 4.4483

Trace

*Handell.*

Autre

Arrêt

Grille

Curseur

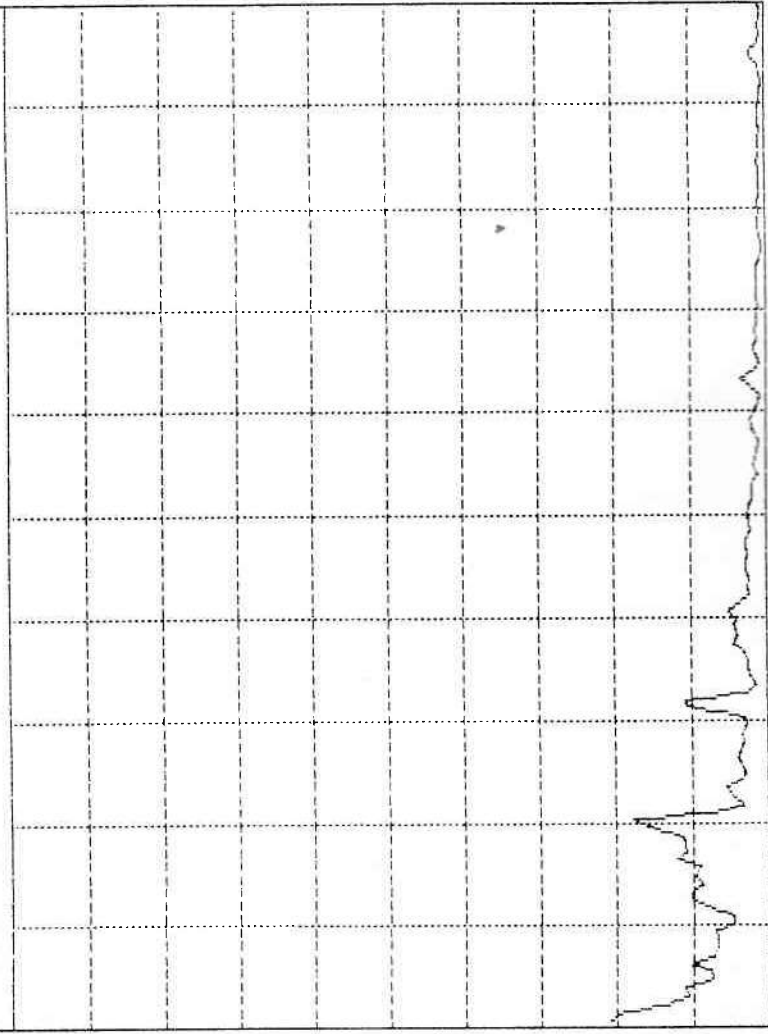
5. TRP/1 1.3517

6. mV RMS 1.6743

TRP/1 68.903

du1:gte009.fft  
trace No 1.

50.  
5.  
mV FS  
mV/div



0. 125. 250.

25. Hz/div

*Handell*

*Handell*

Taper le code du point pour enregistrer ou zero





Zoom X  
Zoom Y  
Zoom X  
Zoom Y  
Cursor  
Trace  
Autre  
Arrêt  
Grille

Curseur  
f, Hz  
1. mV RMS  
2. mV RMS  
3. TRP/1  
4. mV RMS  
5. TRP/1  
6. mV RMS  
7. TRP/1

35.156  
12.477  
11.431  
-32.289  
12.596  
11.25  
10.677  
27.215  
5.4012  
42.565  
2.4002  
21.307

du1:gte010.fft  
trace No 1.

50.  
5.

mV FS  
mV/div

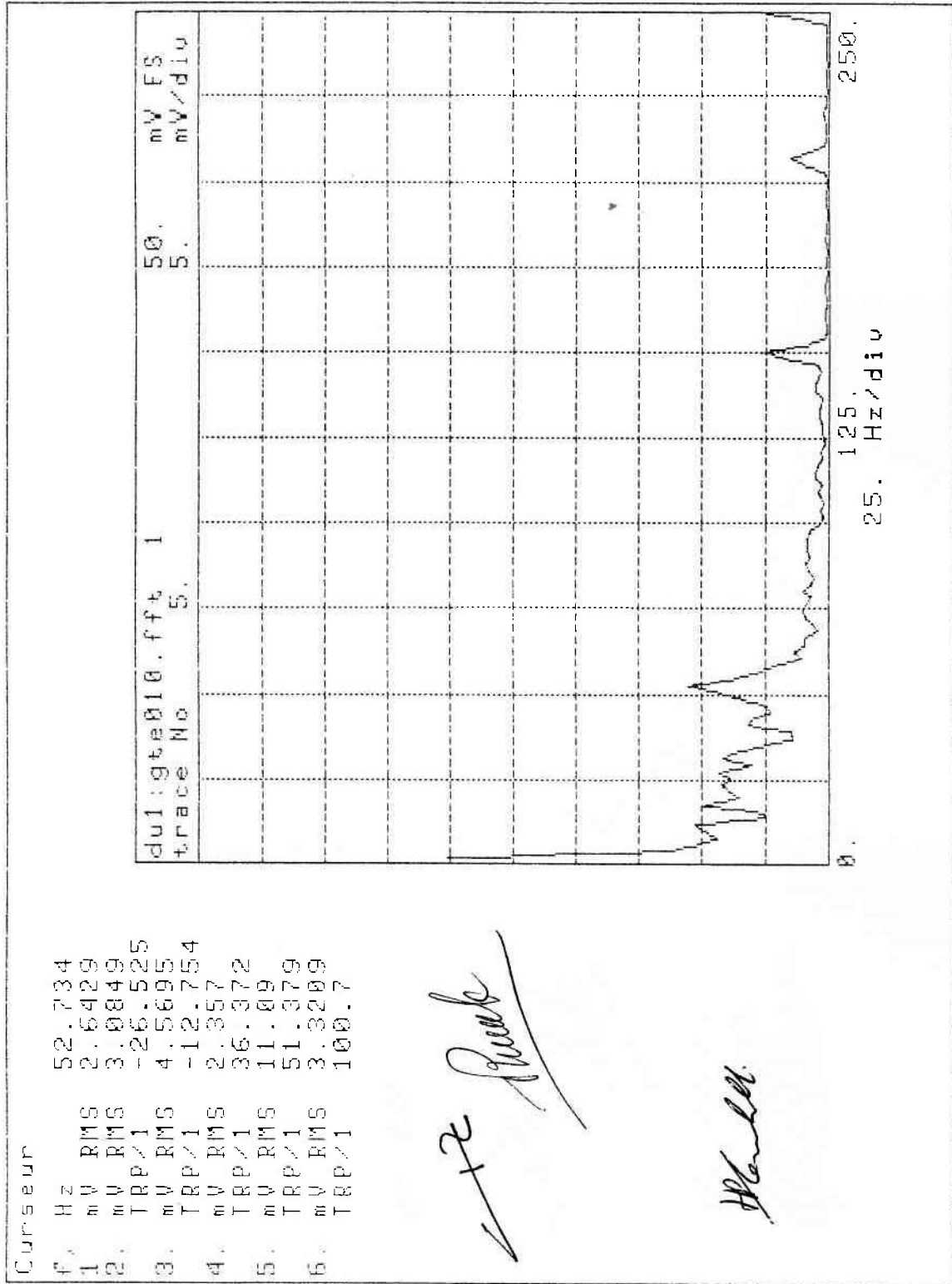
0.  
125.  
250.

25. Hz/div

*Handwritten signature*

*Handwritten signature*

Taper le code du point pour enregistrer au zero



Cancel

Save

Handwritten signature

Handwritten signature

f. Hz 13.672  
 1. mV RMS 22.045  
 2. mV PPS 14.331  
 TRP 1 55.612  
 3. mV RMS 11.081  
 TRP 1 43.464  
 4. mV RMS 15.586  
 TRP 1 16.597  
 5. mV RMS 10.474  
 TRP 1 58.317  
 6. mV RMS 1.0164  
 TRP 1 43.186

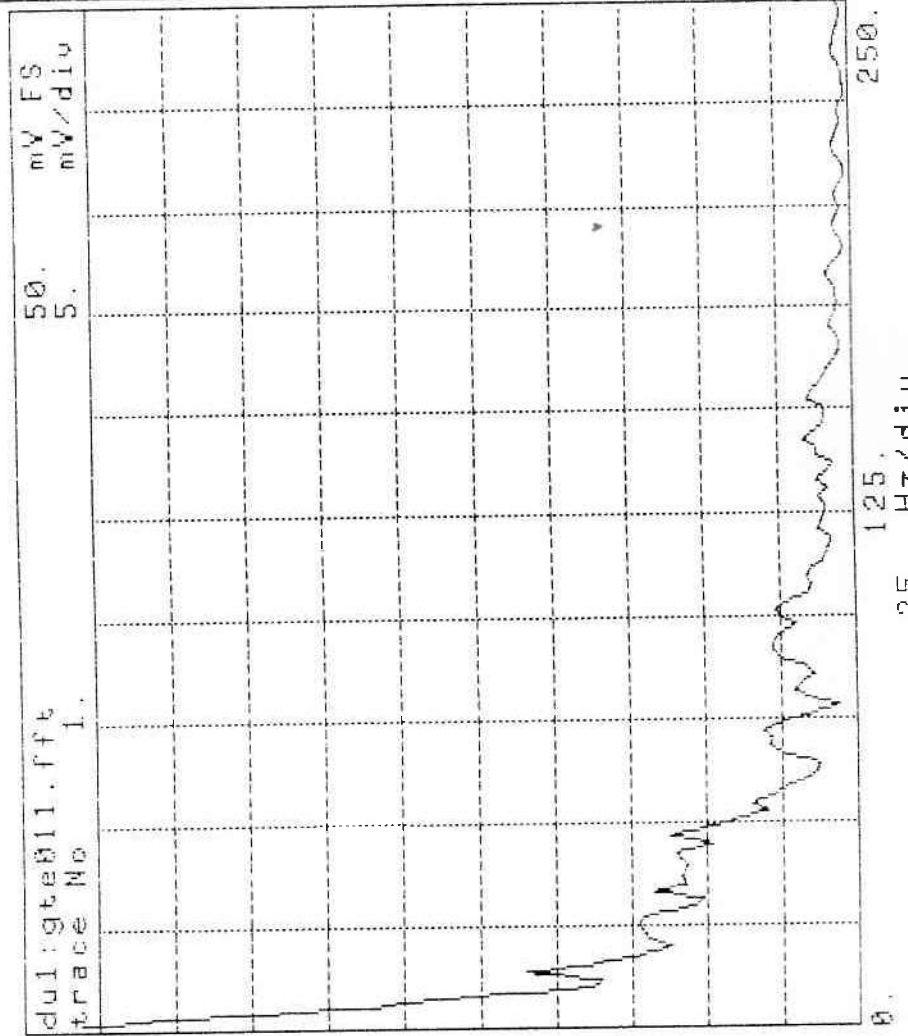
Curseur

Zoom <  
 Zoom >  
 Zoom \*  
 Zoom 0  
 Curseur  
 Trace  
 Autre  
 Arrêt  
 Grille

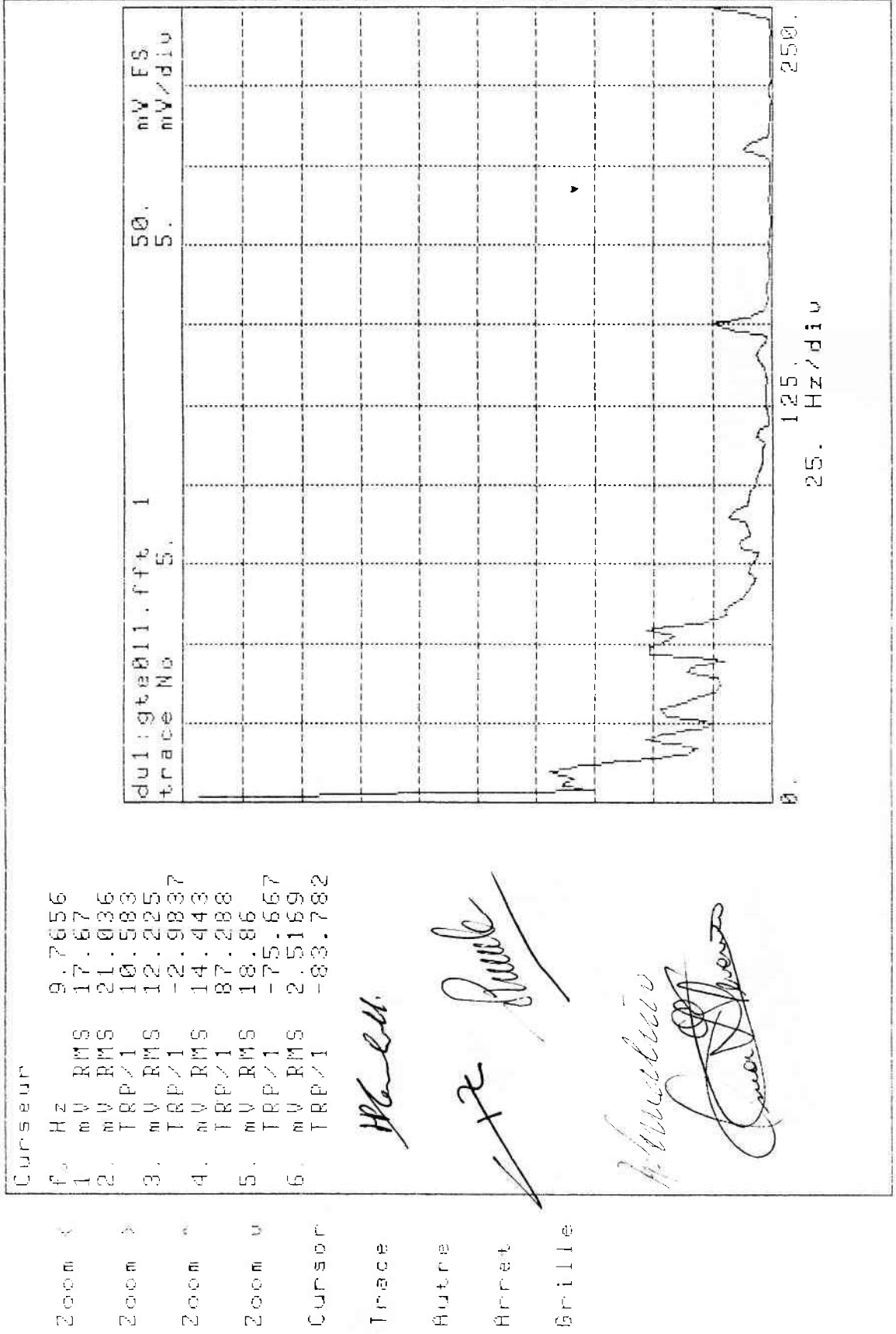
*Handwritten signature*

*Handwritten signature*

*Handwritten signature*







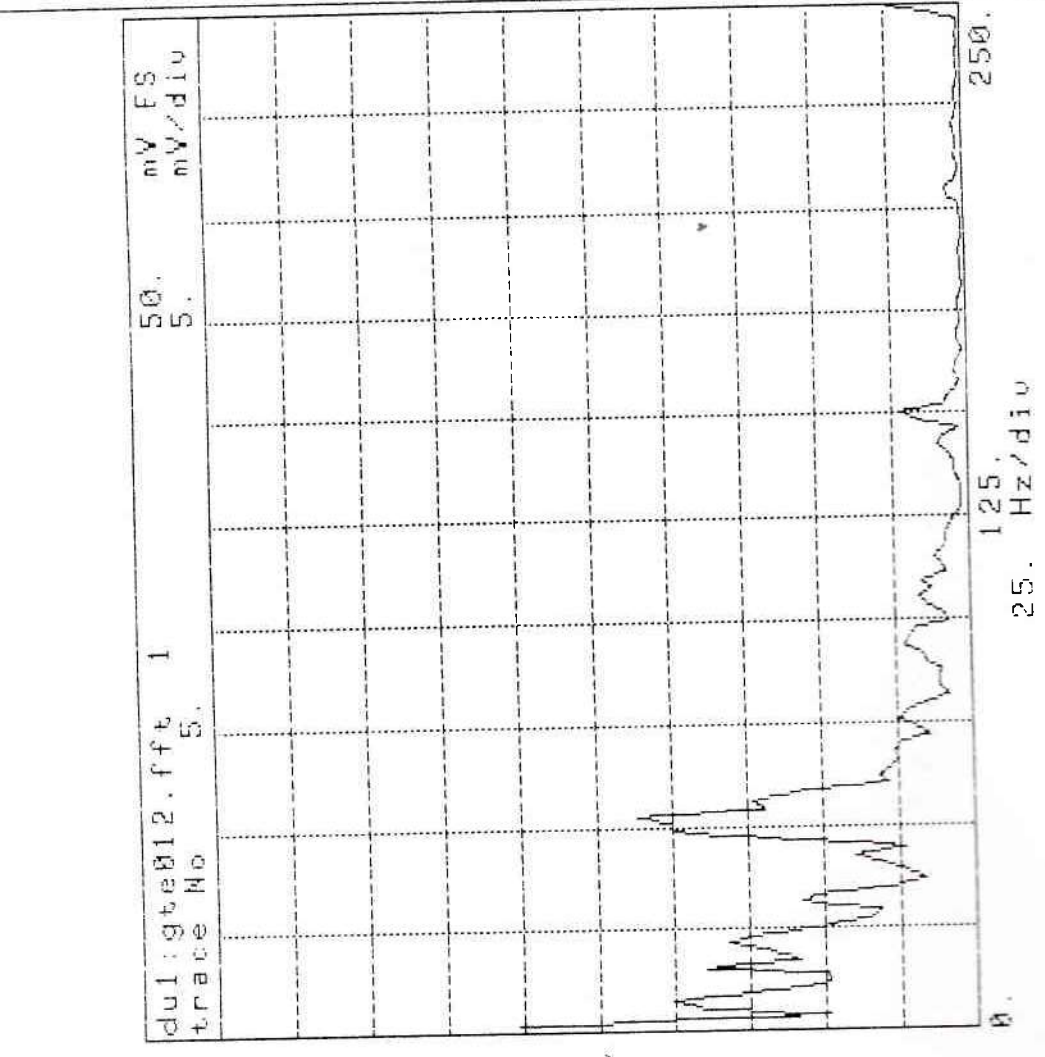
Taper le code du point pour enregistrer ou zero

| Curseur |                 | du1: gte012.fff<br>trace No 1. |  | 50. | mV FS<br>mV/div |
|---------|-----------------|--------------------------------|--|-----|-----------------|
| Zoom <  | f, Hz           | 42.969                         |  |     |                 |
|         | 1. mV RMS       | 21.206                         |  |     |                 |
| Zoom >  | 2. mV RMS       | 18.292                         |  |     |                 |
|         | 3. TRP/1        | -24.824                        |  |     |                 |
|         | 4. mV RMS       | 16.603                         |  |     |                 |
|         | 5. TRP/1        | 18.196                         |  |     |                 |
|         | 6. mV RMS       | 19.52                          |  |     |                 |
|         | 7. TRP/1        | 3.1187                         |  |     |                 |
|         | 8. mV RMS       | 7.8795                         |  |     |                 |
|         | 9. TRP/1        | 129.37                         |  |     |                 |
|         | 10. mV RMS      | 3.4012                         |  |     |                 |
|         | 11. TRP/1       | -133.14                        |  |     |                 |
| Trace   | <i>Heck</i>     |                                |  |     |                 |
| Autre   |                 |                                |  |     |                 |
| Arrêt   | <i>✓</i>        |                                |  |     |                 |
| Grille  | <i>Quadrant</i> |                                |  |     |                 |

0. 125. 250.

25. Hz/div

Zoom X 52.734  
 Zoom Y 10.068  
 Zoom Z 15.314  
 Zoom W -48.268  
 Zoom V 12.134  
 Zoom U -6.9955  
 Cursor 13.793  
 Trace 22.273  
 Autre 63.732  
 Arrêt 9.9536  
 Grille 117.75



*Handwritten signatures and notes:*  
 - A signature that looks like "H. ex."  
 - A signature that looks like "t2" followed by "J. ex."  
 - A signature that looks like "M. ex."  
 - A signature that looks like "J. ex."



Zoom <  
Zoom >  
Zoom ~  
Zoom v  
Cursor  
Trace  
Autre  
Arrêt  
Grille

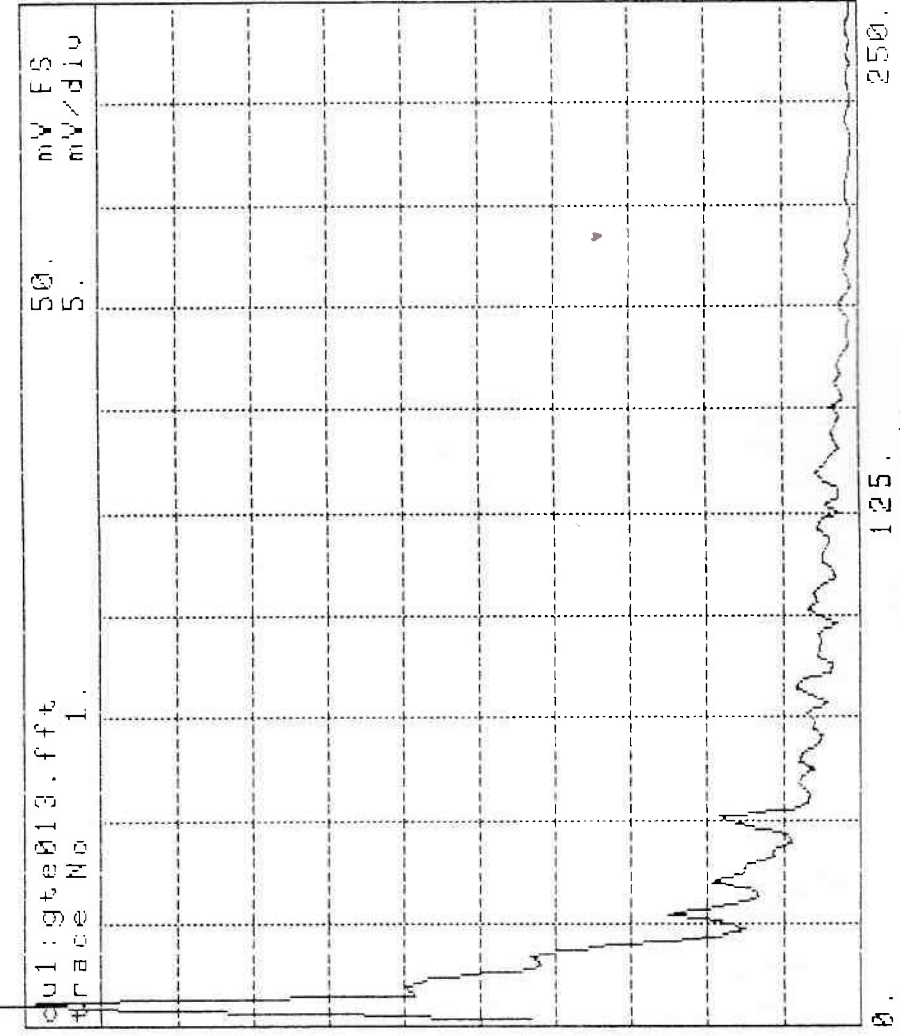
Curseur  
f, Hz  
1. 5.8594  
2. 57.159  
3. 41.469  
4. 67.247  
5. 42.524  
6. 18.672  
7. 60.069  
8. -64.152  
9. 4.1648  
10. 3.3658  
11. 1.3924  
12. 54.027

*De ee.*

*et Juek*

*Benadus*

*Cher Theres*



| Zoom   | f | Hz      | mV RMS | TRP/1 | mV RMS | TRP/1  | mV RMS | TRP/1  |
|--------|---|---------|--------|-------|--------|--------|--------|--------|
| X      | 1 | 23.4937 | 7.4793 | 10.98 | 3.0593 | 11.128 | 16.516 | 8.0689 |
| X      | 2 |         |        |       |        |        |        |        |
| X      | 3 |         |        |       |        |        |        |        |
| X      | 4 |         |        |       |        |        |        |        |
| X      | 5 |         |        |       |        |        |        |        |
| Y      | 6 |         |        |       |        |        |        |        |
| Cursor |   |         |        |       |        |        |        |        |

Massachusetts

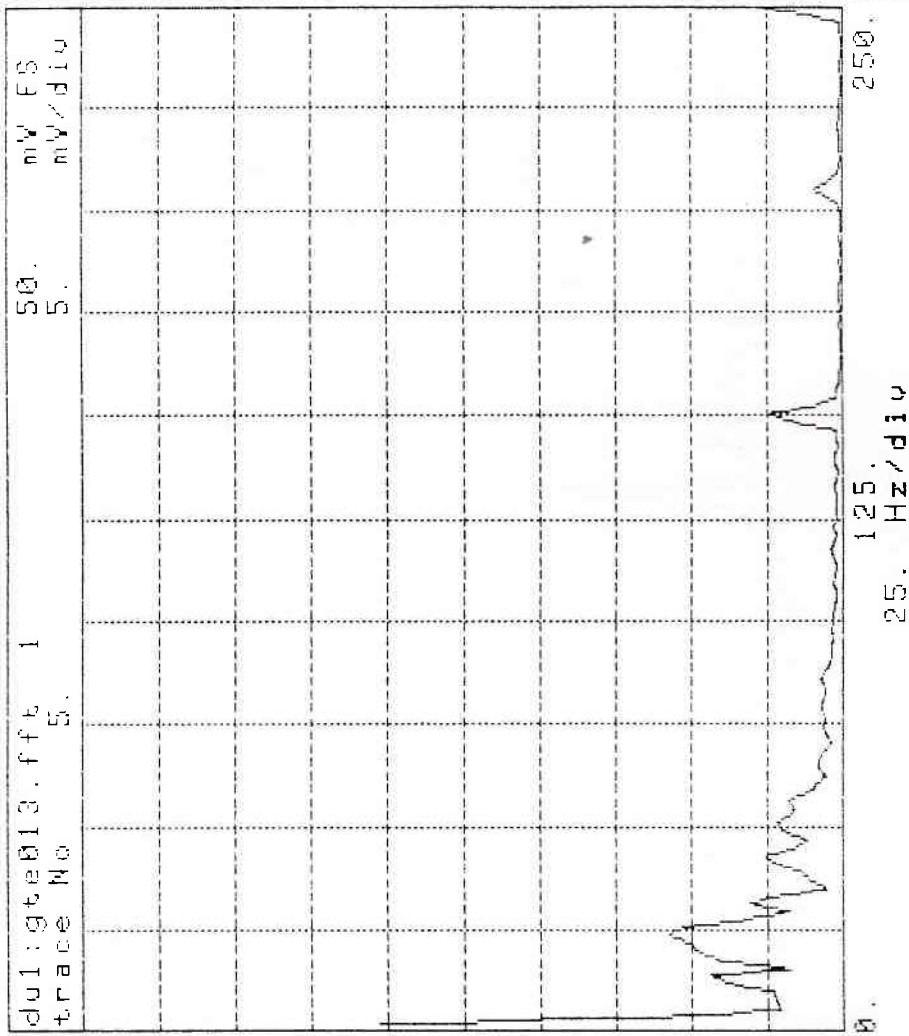
| f  | H z     | $\mu V$ | RMS |
|----|---------|---------|-----|
| 1. | 23.4937 | $\mu V$ | RMS |
| 2. | 27.4798 | $\mu V$ | RMS |
| 3. | 31.0593 | TRP/1   |     |
| 4. | 36.516  | $\mu V$ | RMS |
| 5. | 41.492  | TRP/1   |     |
| 6. | 47.662  | $\mu V$ | RMS |
|    | 52.927  | TRP/1   |     |
|    | 58.302  | $\mu V$ | RMS |

1-3-52

இந்திய

HELPS

51115



Taper le code du point pour enregistrer au zero

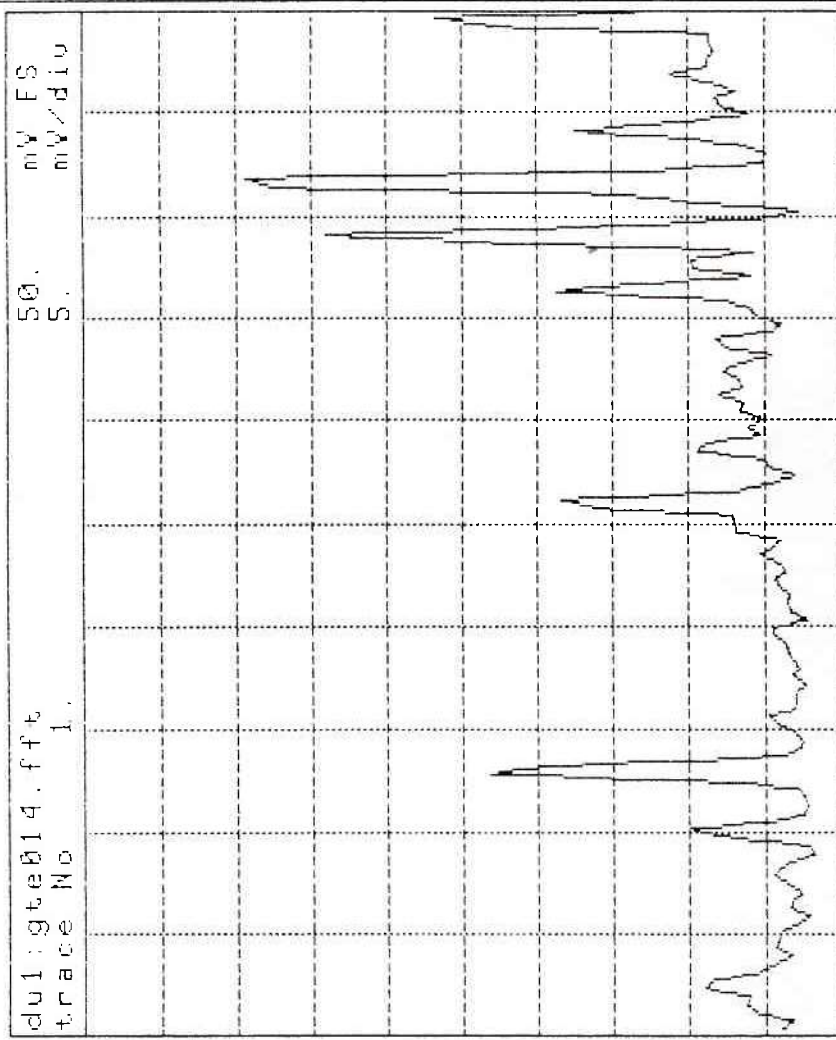
Zoom <  
Zoom >  
Zoom \*  
Zoom 0  
Cursor  
Trace  
Autre  
Arrêt  
Grille

Curseur  
f. Hz 208.98  
1. mV RMS 39.303  
2. mV RMS 16.549  
3. TRP/1 101.33  
4. mV RMS 9.5101  
5. TRP/1 124.71  
6. mV RMS 11.726  
7. TRP/1 117.53  
8. mV RMS 0.97434  
9. TRP/1 61.97  
10. mV RMS 1.3687  
11. TRP/1 67.671

*Handwritten signature*

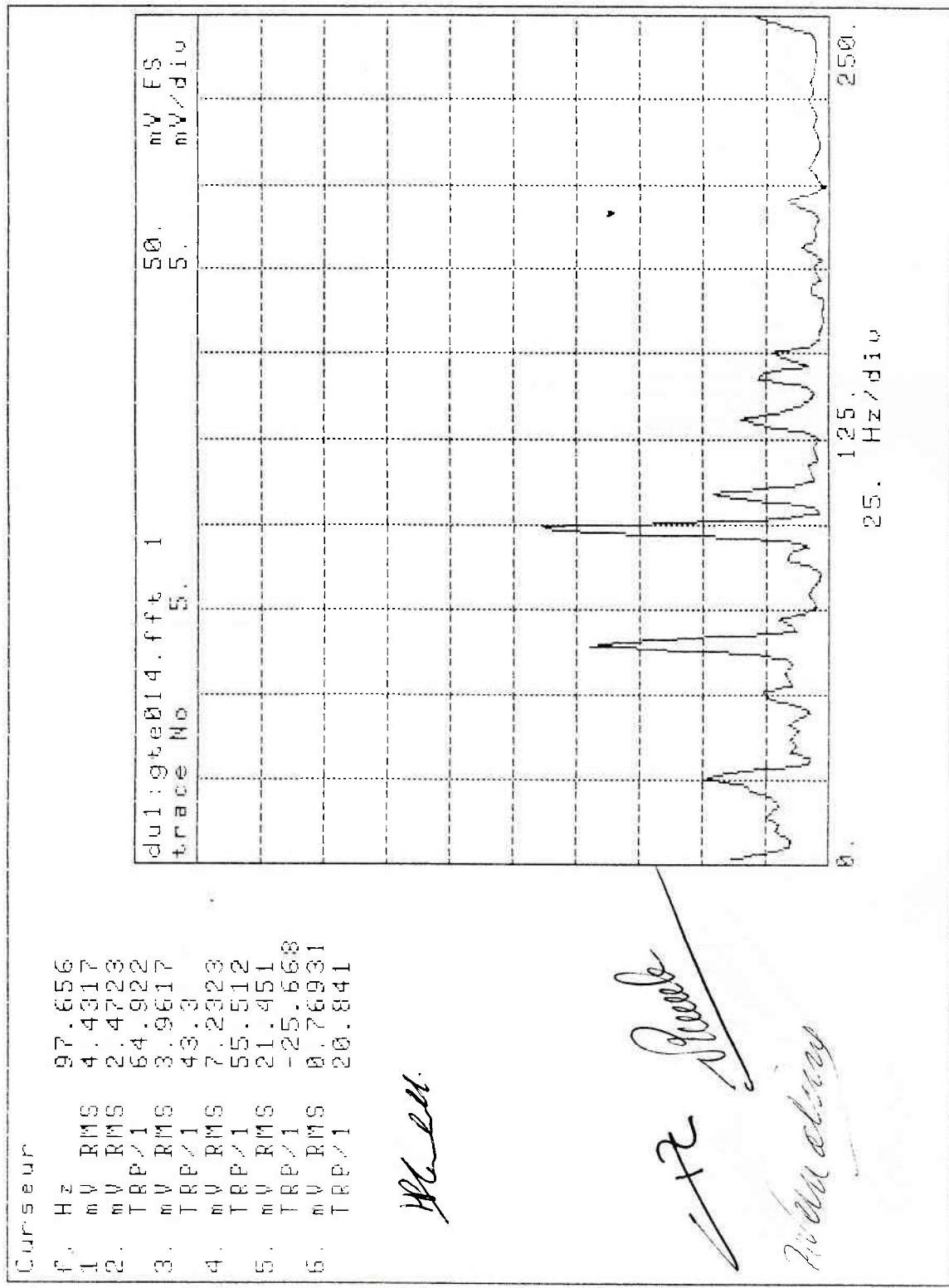
*Handwritten signature*

*Handwritten signature*



0. 25. Hz/div 250.





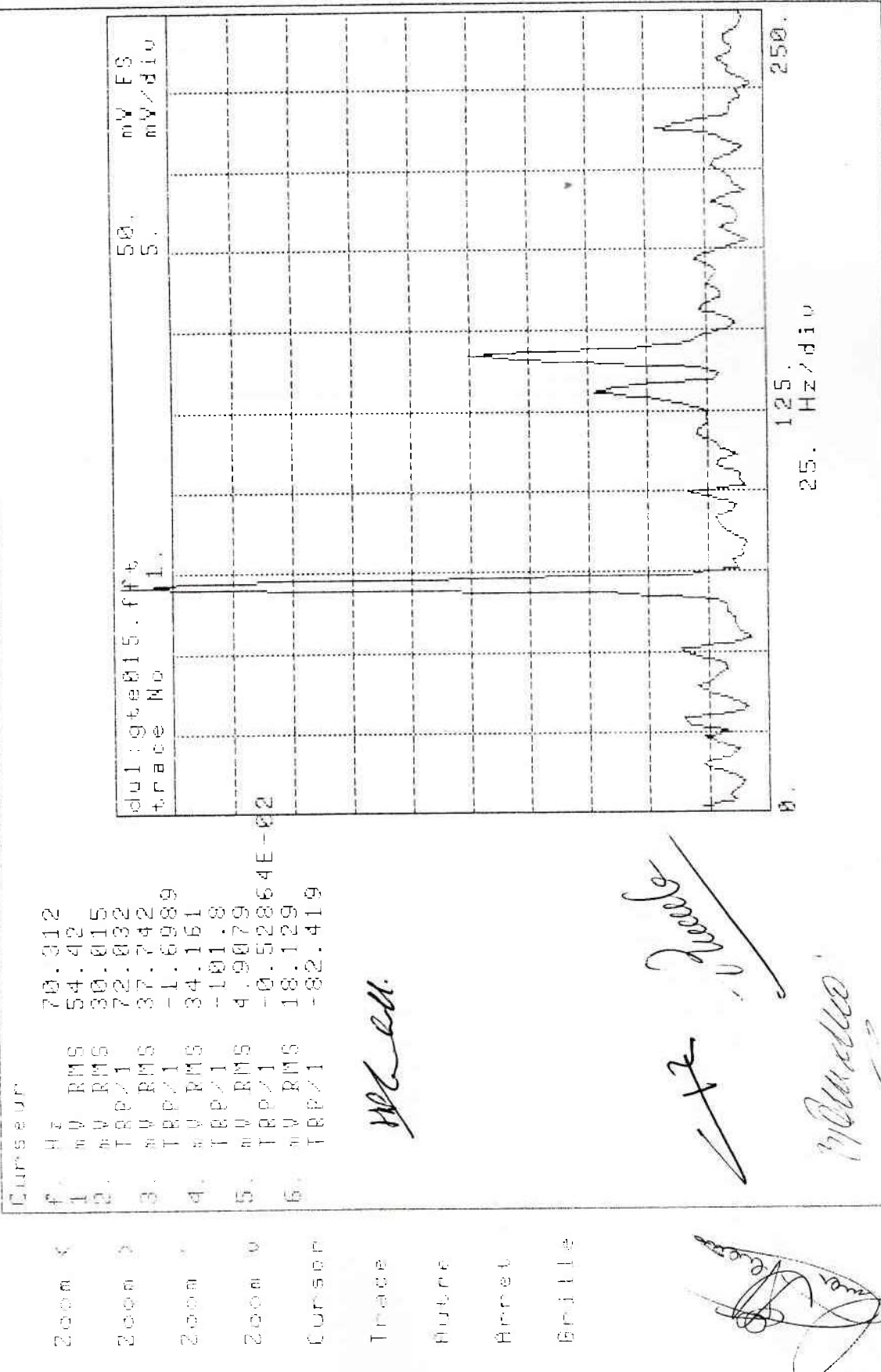
Zoom <  
Zoom >  
Zoom ~  
Zoom v  
Cursor  
Trace  
Autre  
Arrêt  
Grille

*[Signature]*

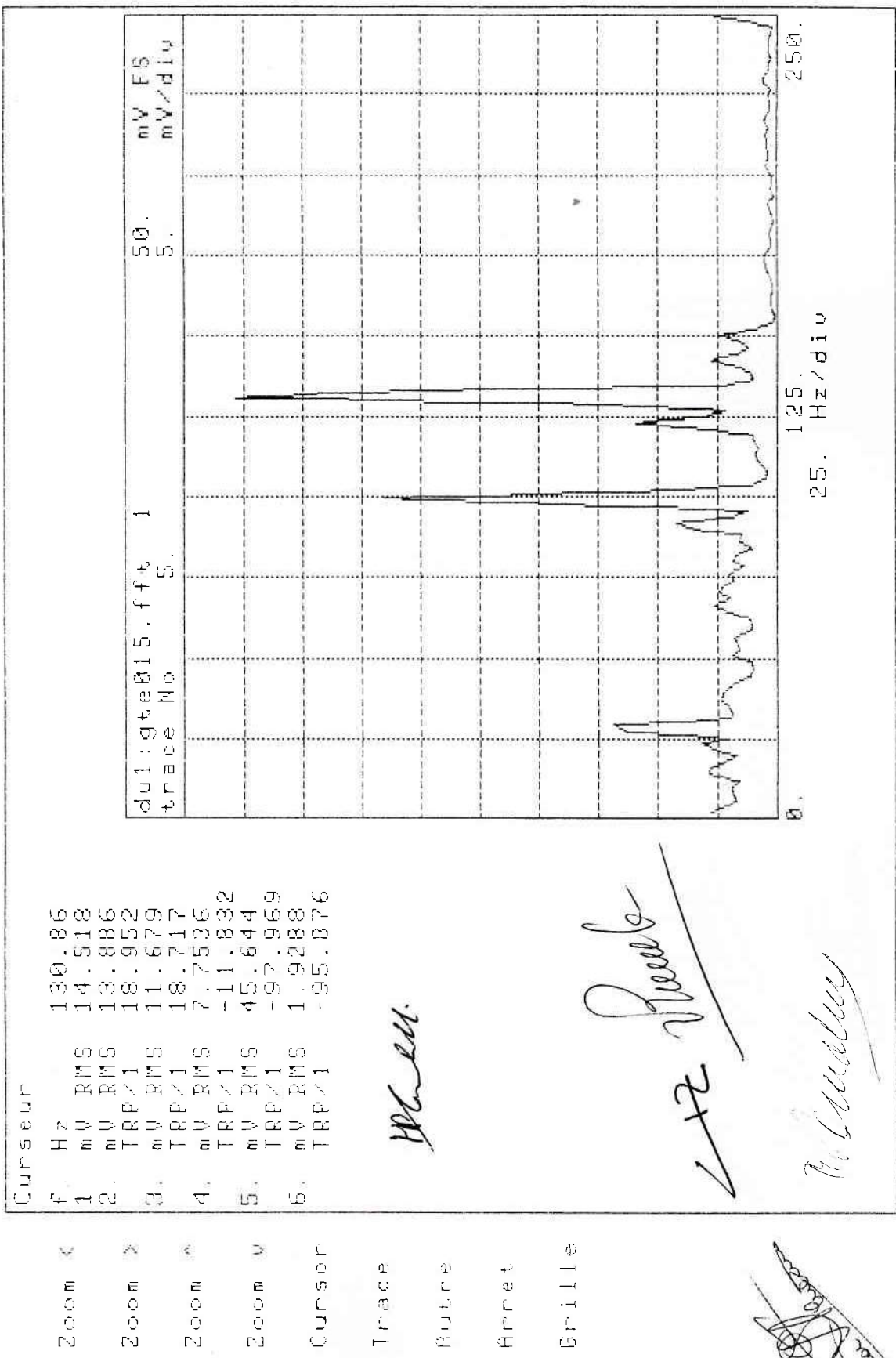
*[Signature]*

*[Signature]*

*[Signature]*



Appuyer le code du point pour enregistrer ou zéro



| Curseur | f.      | Hz | mV RMS |
|---------|---------|----|--------|
| 1.      | 130.86  |    |        |
| 2.      | 14.518  |    |        |
| 3.      | 13.886  |    |        |
| 4.      | 18.952  |    |        |
| 5.      | 11.679  |    |        |
| 6.      | 18.717  |    |        |
| 7.      | 7.7536  |    |        |
| 8.      | -11.832 |    |        |
| 9.      | 45.644  |    |        |
| 10.     | -92.969 |    |        |
| 11.     | 1.9288  |    |        |
| 12.     | -95.876 |    |        |

*W. M.*

*1200*

*W. M.*



FORM 2

2000

2000

5  
E  
O  
O

10571

1000

五、六、七、八、九

421

15

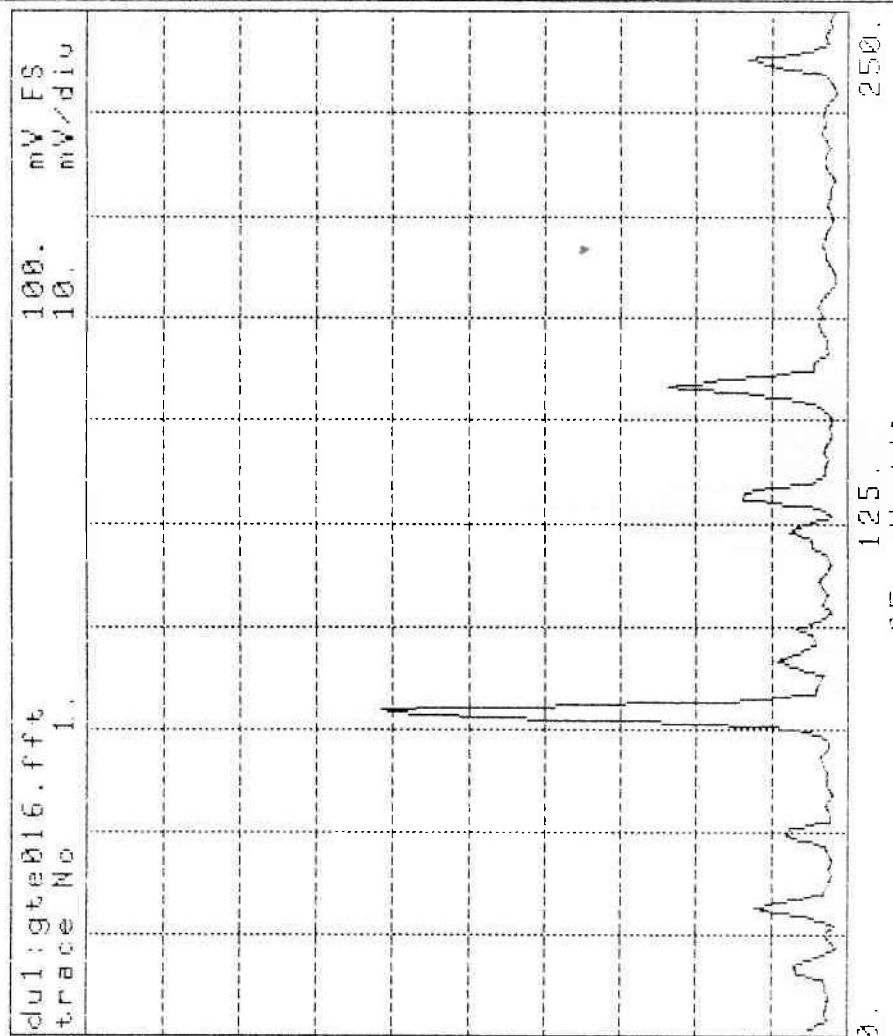
Curran

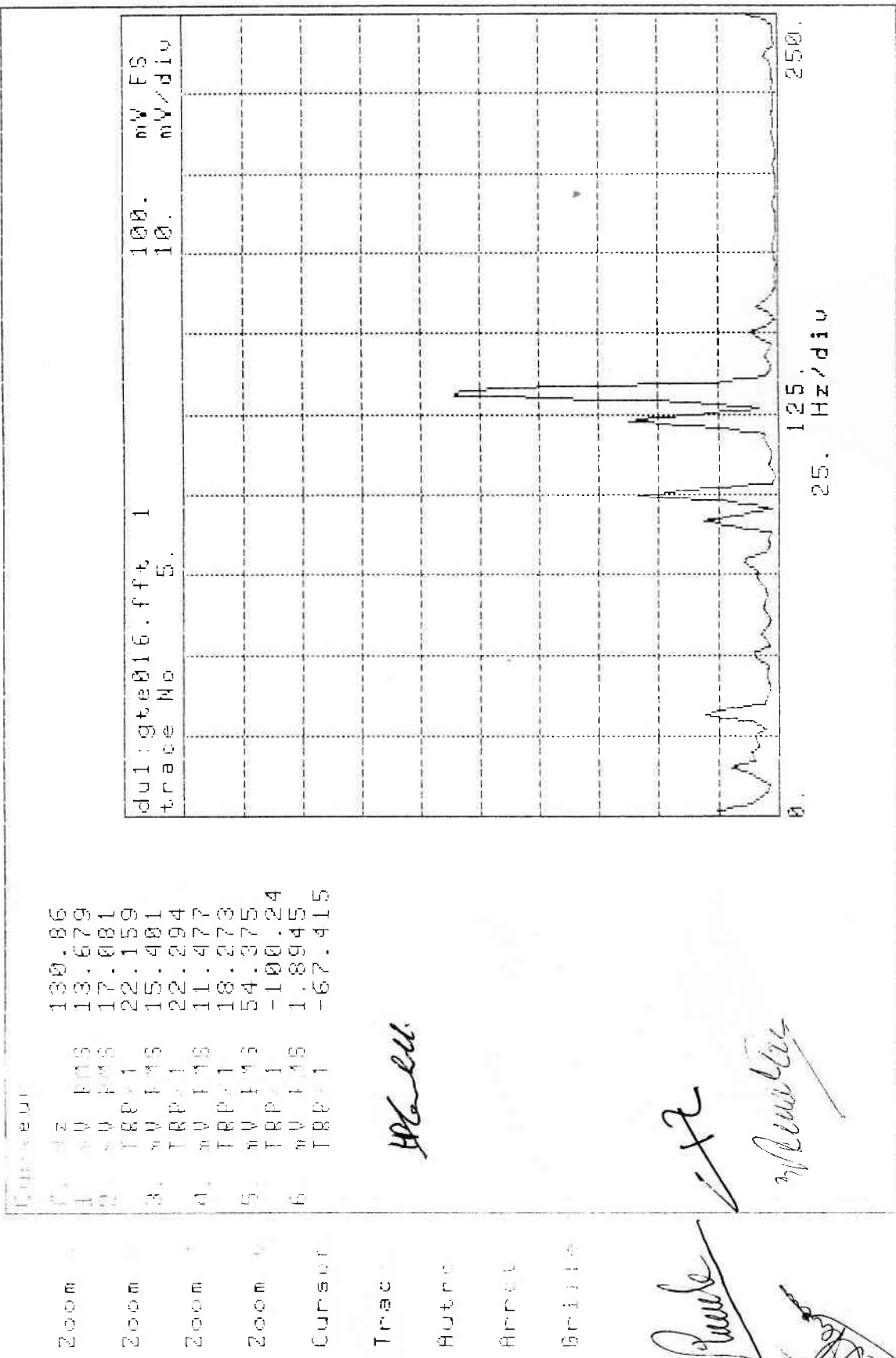
| f. | Hz | mV  | RMS  | TRP/1 | mV  | RMS  | TRP/1 |
|----|----|-----|------|-------|-----|------|-------|
| 1. |    | 39. | 0.73 |       | 51. | 6.19 |       |
| 2. |    | 30. | 2.84 |       | 31. | 0.43 |       |
| 3. |    | 29. | 1.7  |       | 17. | 2.49 |       |
| 4. |    | 31. | 9.38 |       | 10. | 3.28 |       |
| 5. |    | 5.  | 5.86 |       | 3.  | 9.63 |       |
| 6. |    | 6.  | 0.31 |       | 85. | 4.78 |       |

W. L. M.

✓ 2

*[Handwritten signature]*





Zoom 1 130.866  
Zoom 2 13.679  
Zoom 3 17.081  
Zoom 4 22.159  
Zoom 5 15.401  
Zoom 6 22.294  
Zoom 7 11.477  
Zoom 8 18.273  
Zoom 9 54.375  
Zoom 10 -100.24  
Zoom 11 1.8945  
Zoom 12 -67.415

*W. L.*

*Paul*  
*W. L.*





Zoom

200m

500

2000

SECRET

100-1

हुत

11-10-64

Gilling

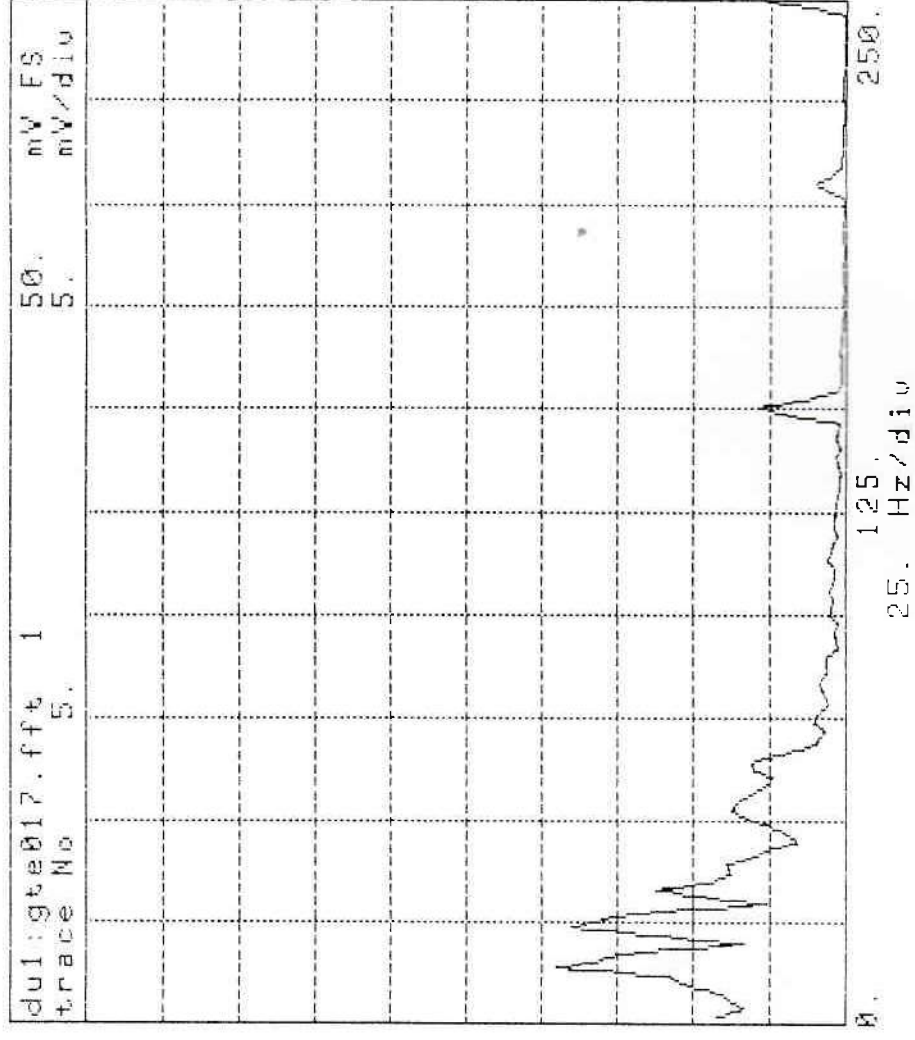
4185111

| f  | Hz    | mV RMS | mV RMS |
|----|-------|--------|--------|
| 1. | TRP/1 | 19.672 | 7.3246 |
| 2. | TRP/1 | 6.8631 | 44.544 |
| 3. | TRP/1 | 4.994  | 4.3223 |
| 4. | TRP/1 | 4.7219 | 19.064 |
| 5. | TRP/1 | 103.86 | 61.973 |
| 6. | TRP/1 | 61.973 |        |

W. L. M.

2 Quale

3/ General



NONO

Zoom

300

0000

3057

1000

44

CHILL

Figure 11

2185471

|    |                |     |  |  |        |
|----|----------------|-----|--|--|--------|
| f. | H <sub>2</sub> |     |  |  | 13.672 |
| 1. | wv             | RM5 |  |  | 14.116 |
| 2. | wv             | RM5 |  |  | 7.935  |
|    | TRP/1          |     |  |  | 76.49  |
| 3. | wv             | RM5 |  |  | 7.284  |
|    | TRP/1          |     |  |  | 9.1938 |
| 4. | wv             | RM5 |  |  | 9.777  |
|    | TRP/1          |     |  |  | 9.69   |
| 5. | wv             | RM5 |  |  | 86.427 |
|    | TRP/1          |     |  |  | 1.6218 |
| 6. | wv             | RM5 |  |  | 66.656 |
|    | TRP/1          |     |  |  |        |

W. L. L.

✓ to Duke  
✓ Tucker  
✓ Duke

President

*Inde Brent*

du1:gte018. ffb  
trace No. 1.

my ES  
my div

|            |      |
|------------|------|
| 125.       | 125. |
| 25. HZ/dio | 250. |

Taper le code du point pour enregistrer au zéro

3003

NONO

# NOON

Zoom 5

10577

Page 2

Autore

Heil

1  
1  
1  
1  
1

ARIES JUN 7

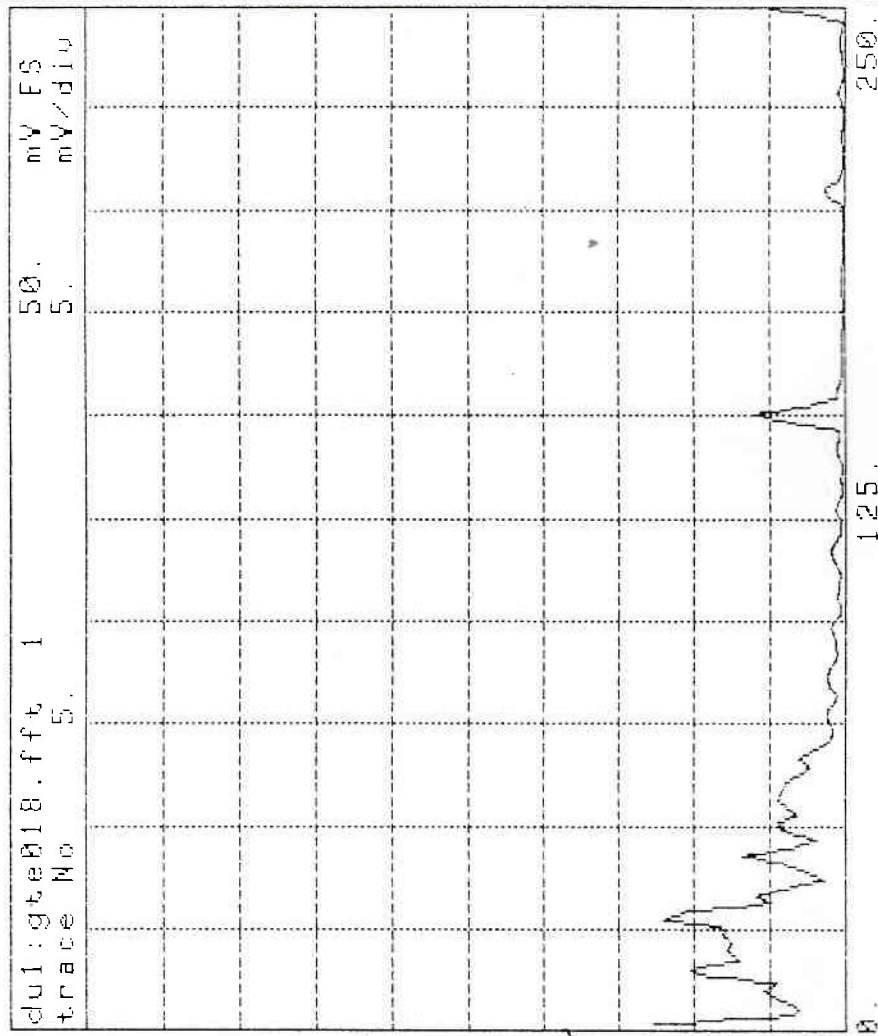
|    | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> |
|----|----------------|----------------|----------------|----------------|----------------|----------------|
| 1. | WV RMS         | 27.9344        | WV RMS         | 27.9393        | WV RMS         | 27.9393        |
| 2. | WV RMS         | 31.0144        | WV RMS         | 31.0144        | WV RMS         | 31.0144        |
| 3. | TRP/1          | 21.8343        | TRP/1          | 21.8343        | TRP/1          | 21.8343        |
| 4. | WV RMS         | 21.0802        | WV RMS         | 21.0802        | WV RMS         | 21.0802        |
| 5. | TRP/1          | 21.7635        | TRP/1          | 21.7635        | TRP/1          | 21.7635        |
| 6. | WV RMS         | 12.054         | WV RMS         | 12.054         | WV RMS         | 12.054         |
|    | TRP/1          | 13.274         | TRP/1          | 13.274         | TRP/1          | 13.274         |
|    | WV RMS         | 11.4646        | WV RMS         | 11.4646        | WV RMS         | 11.4646        |
|    | TRP/1          | 9.9373         | TRP/1          | 9.9373         | TRP/1          | 9.9373         |

W. L. L.

✓ 2

3/17/2011

4/10  
L. J. [Signature]





Zoom <

Zoom >

Zoom \*

Zoom v

Cursor

Trace

Autre

Arrêt

Grille

Curseur

f.

Hz

RMS

1.

3.9052

2.

10.109

3.

7.633

4.

100.63

5.

10.098

6.

-77.103

7.

8.3806

8.

-71.125

9.

4.0146

10.

-59.148

11.

0.50516

12.

-44.773

du1:gte019.fft

trace No

1.

50.

5.

mV FS

mV/div

0.

25.

125.

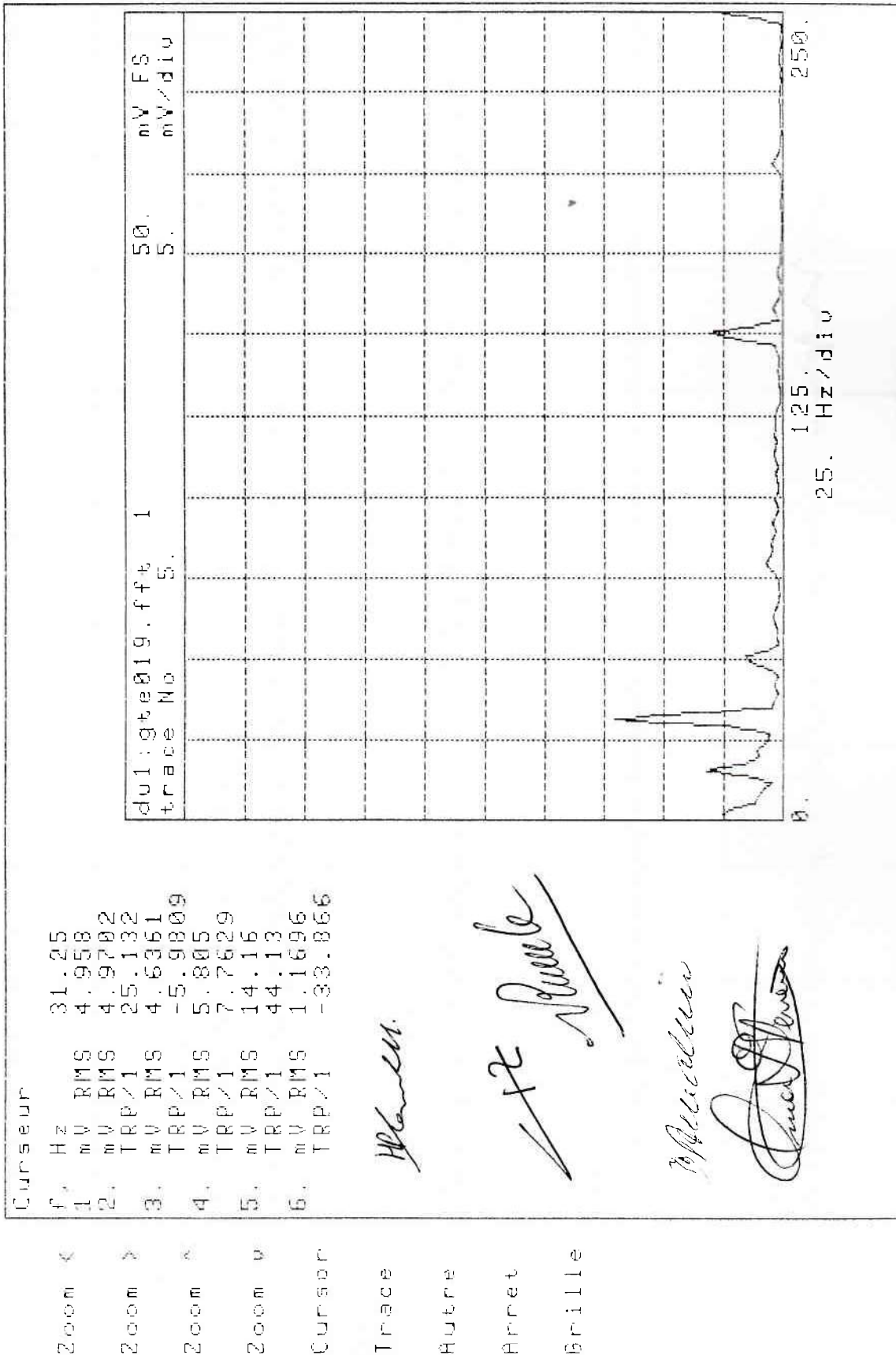
250.

Hz/div

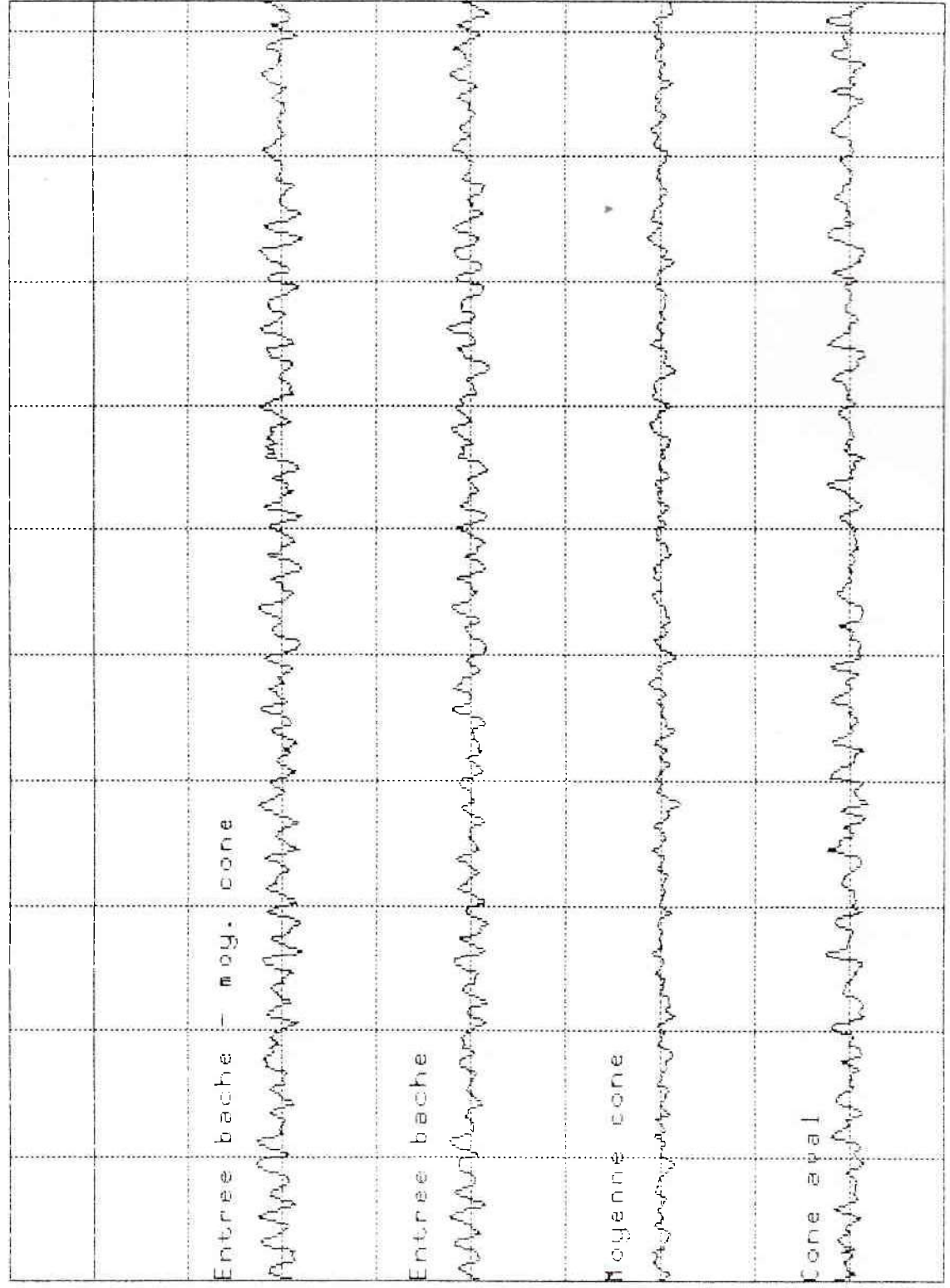
0.

250.

Taper le code du point pour enregistrer ou zero

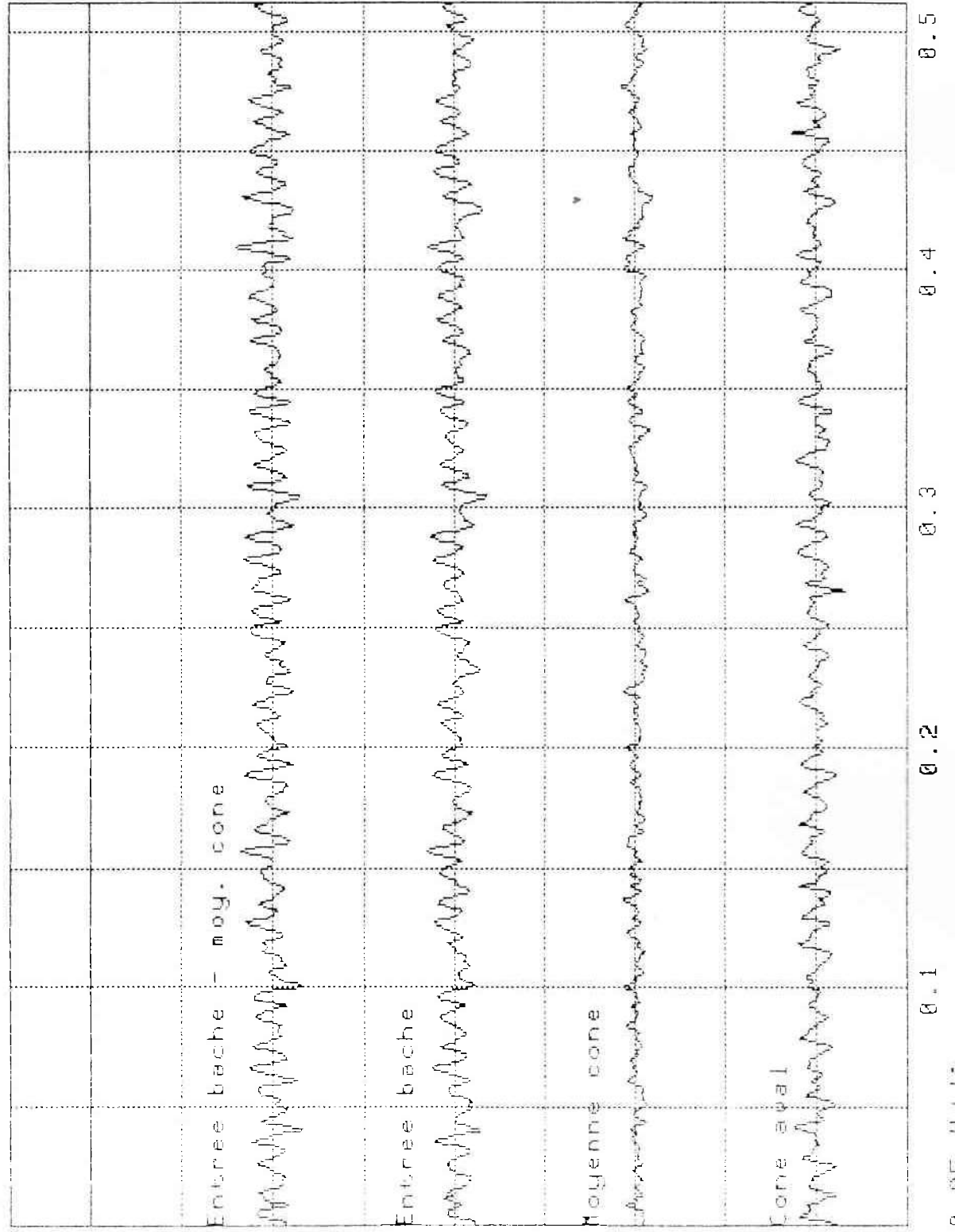


du1:gte002.dat

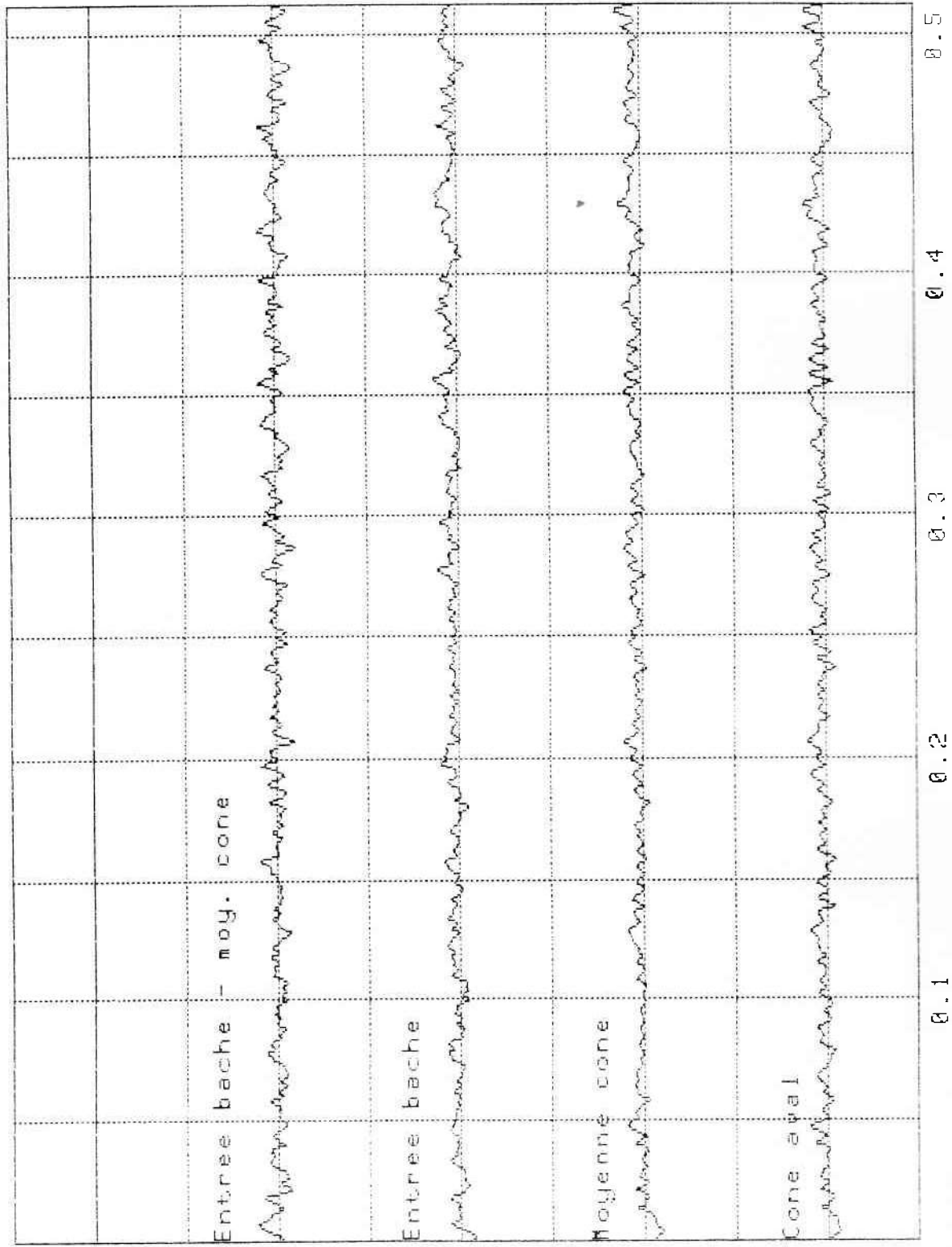




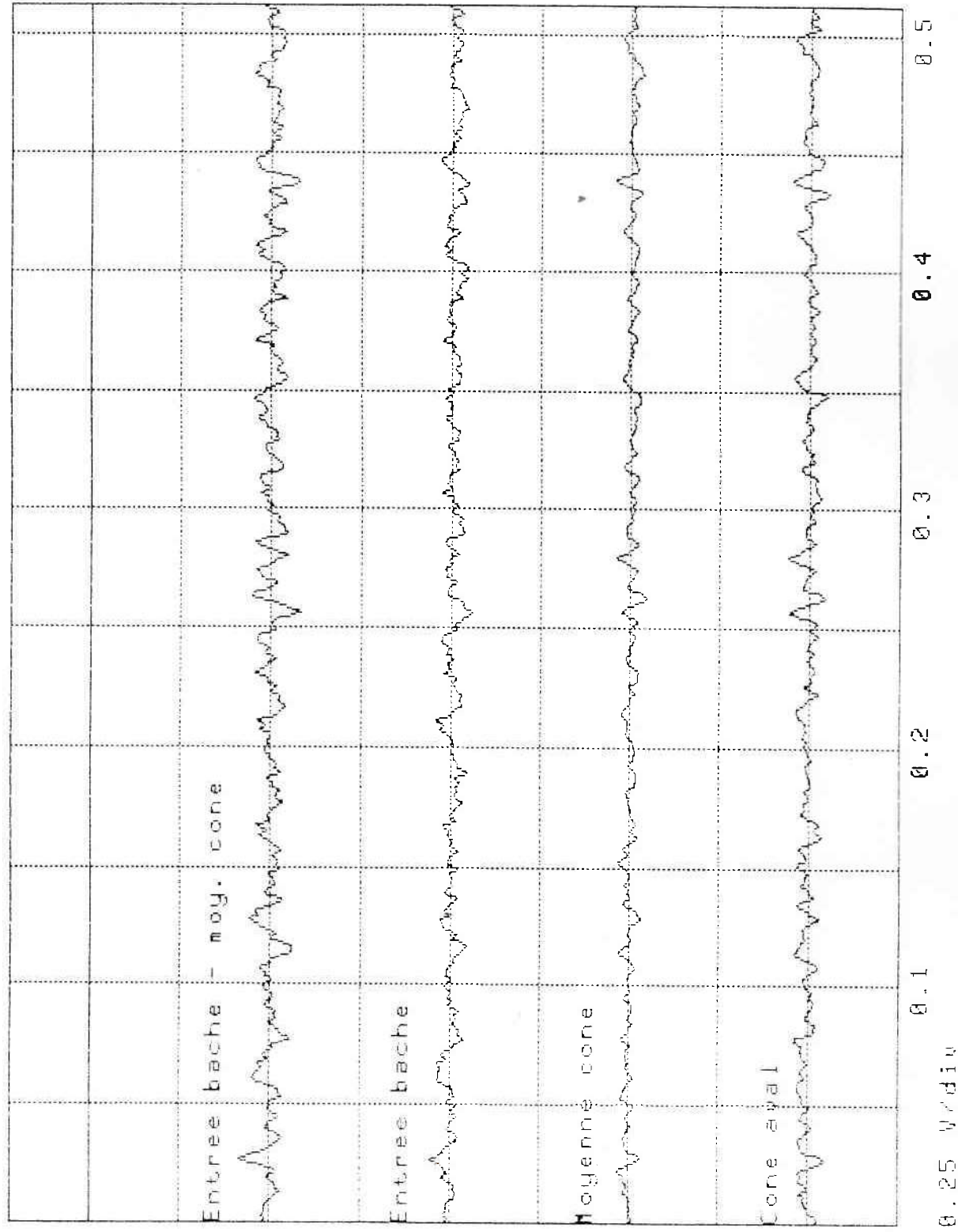
dul:gte003.dat



du1:gte004.dat

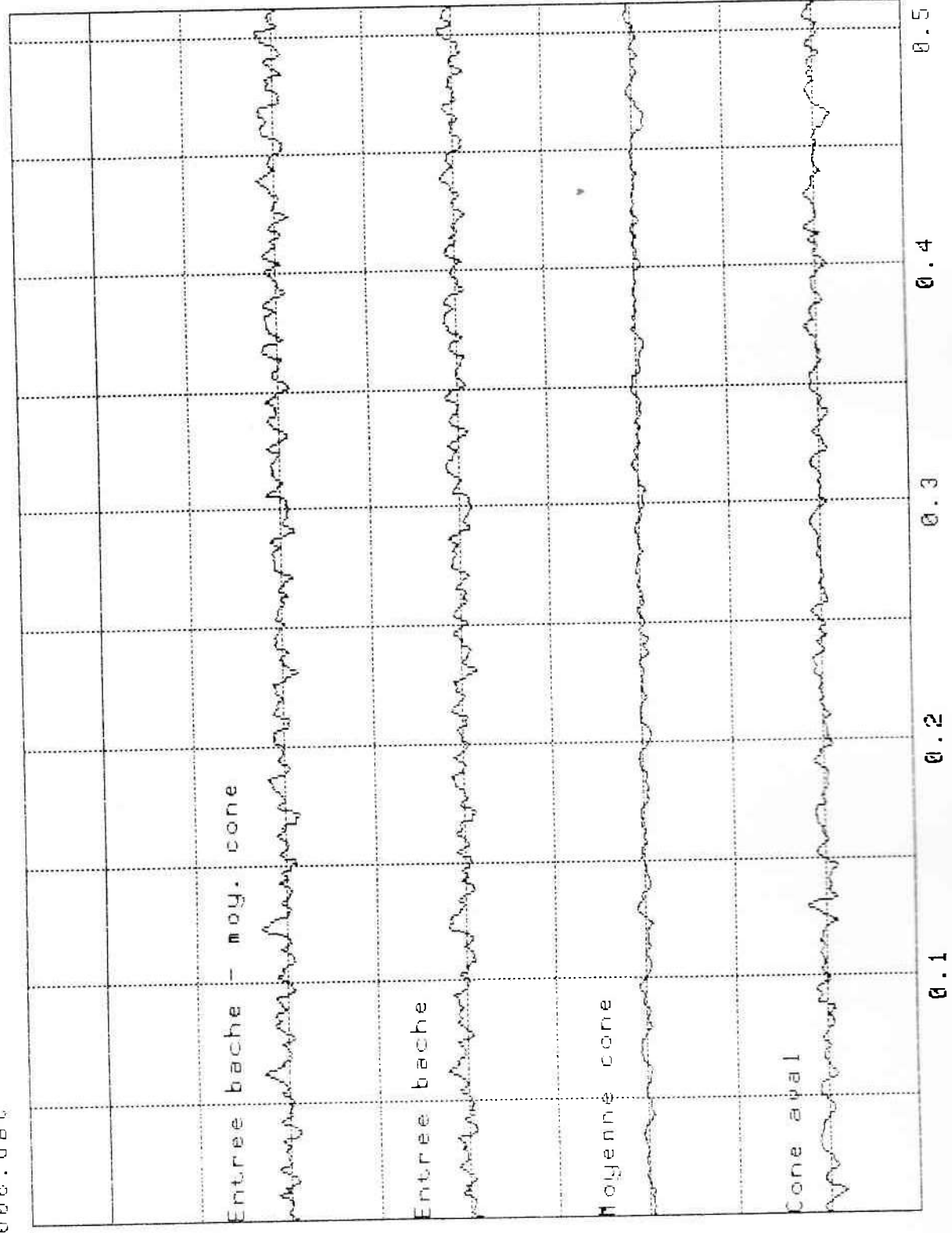


du1:gte005.dat

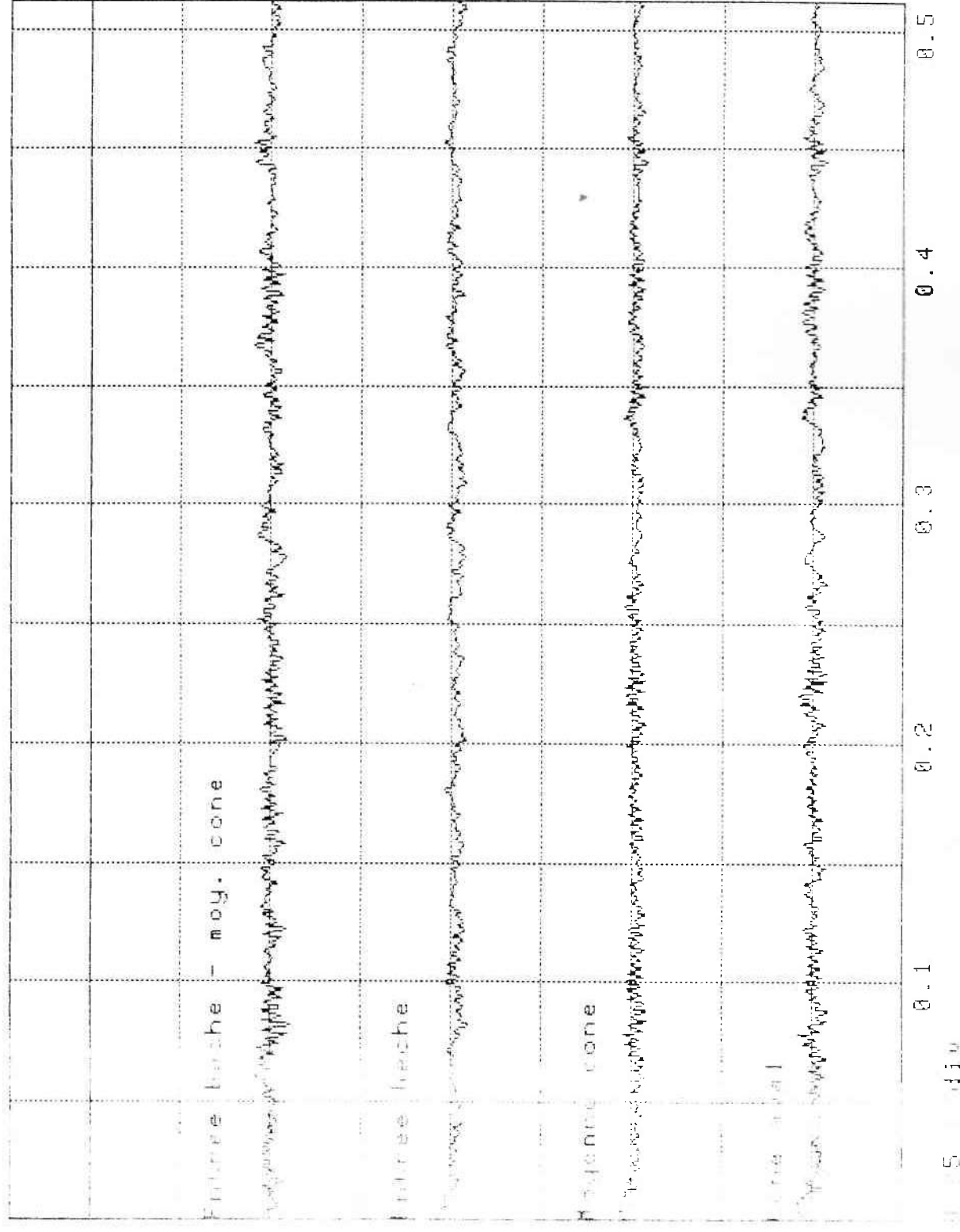




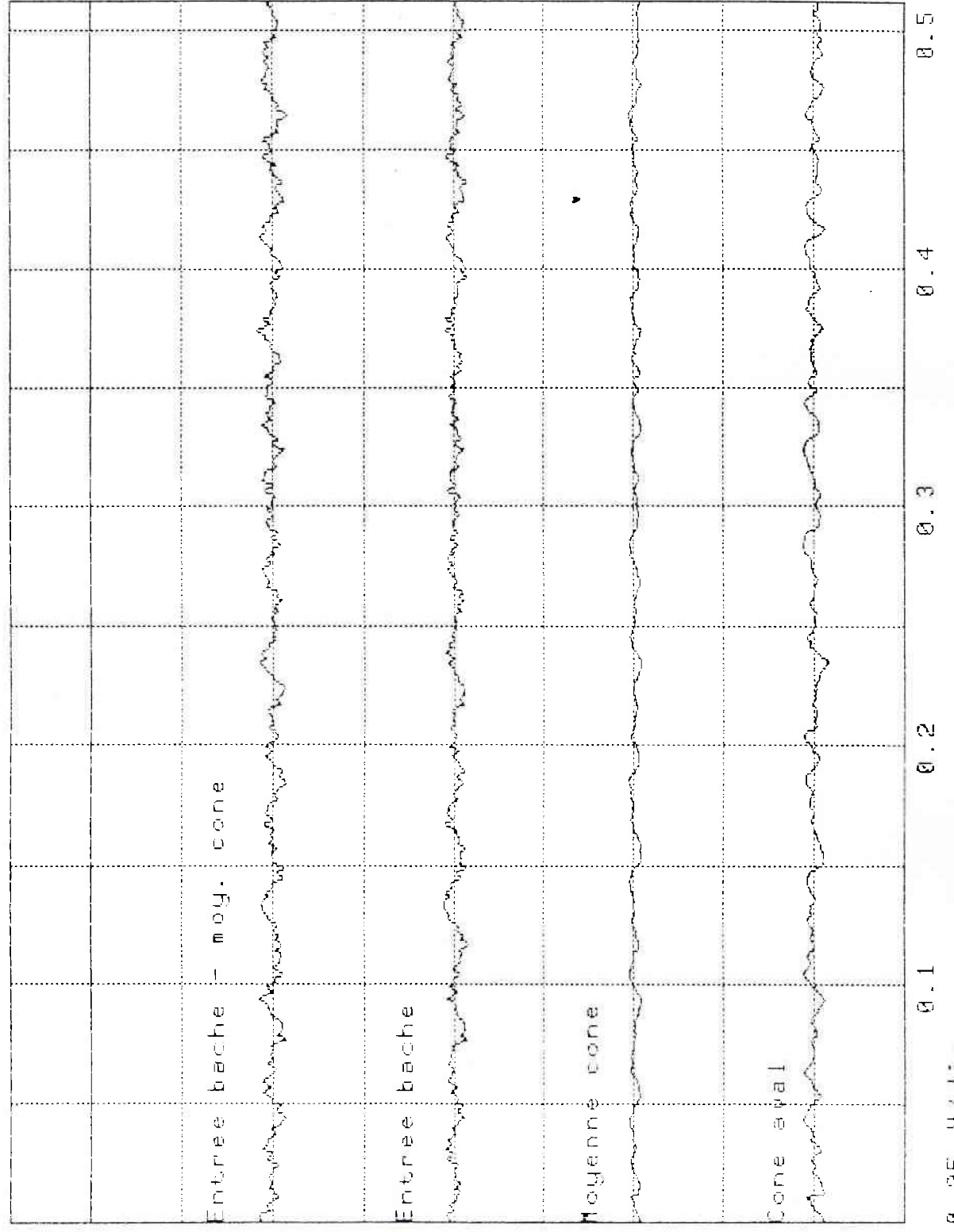
du1:gte006.dat



du1:gte007.dat

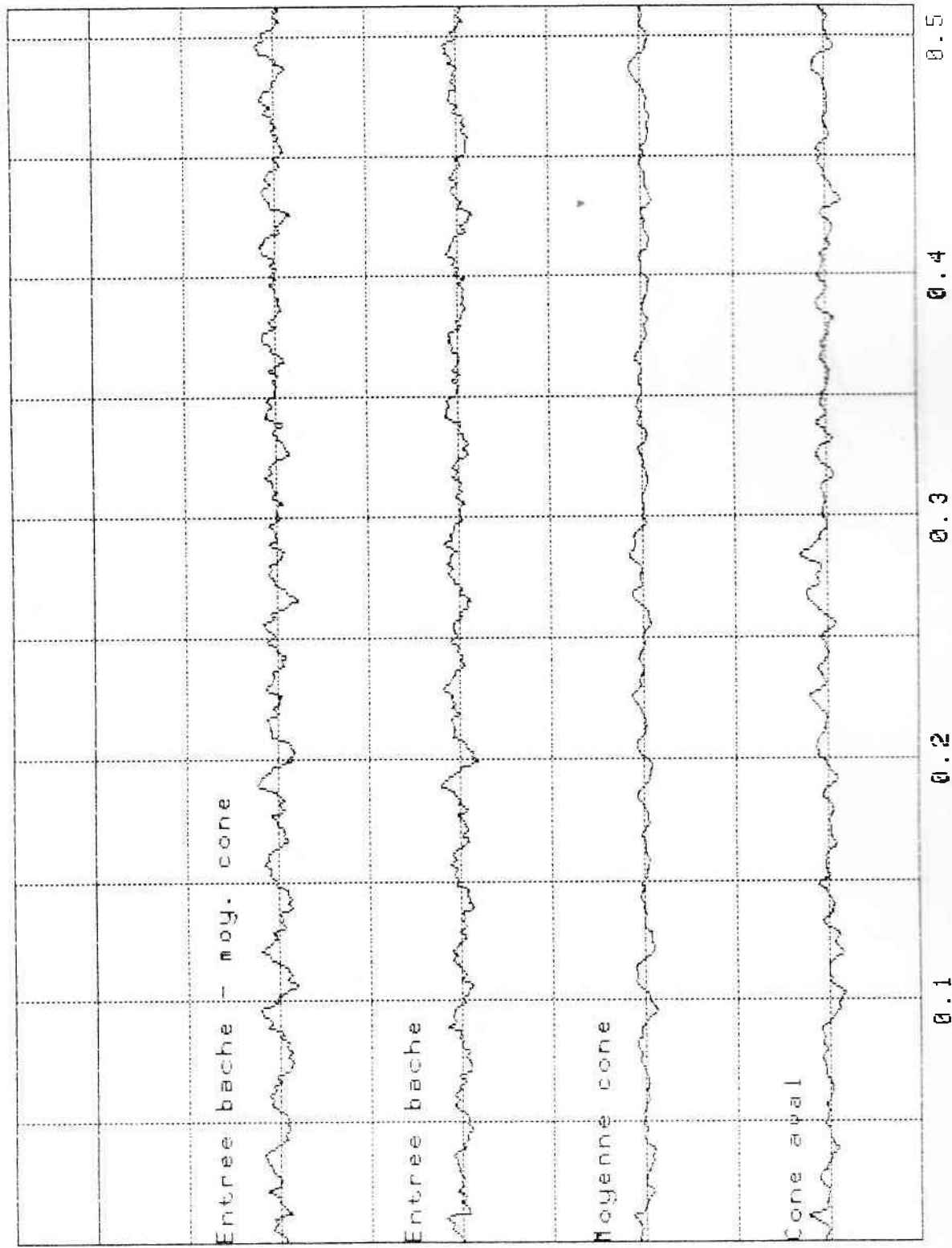


du1:gte008.dat

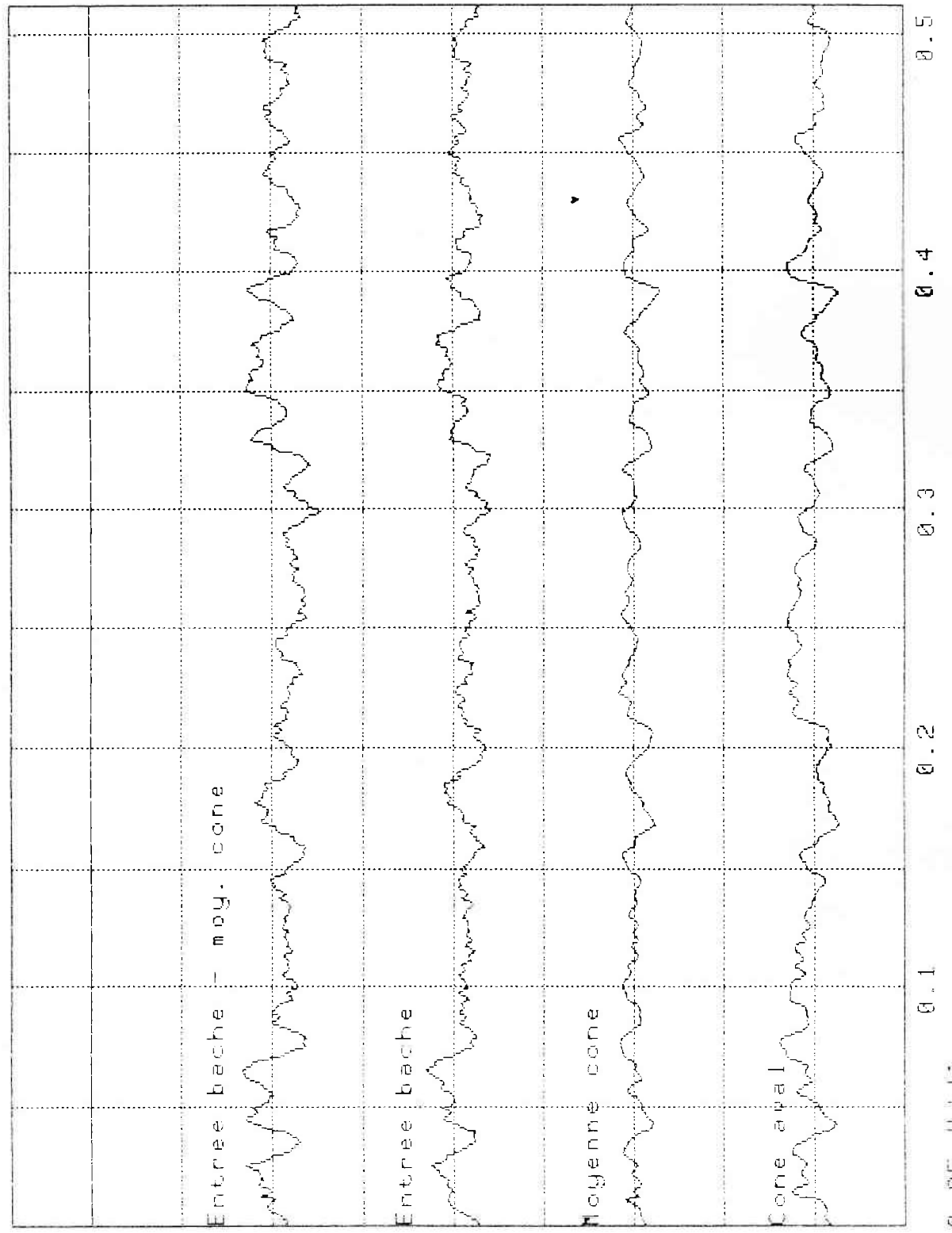




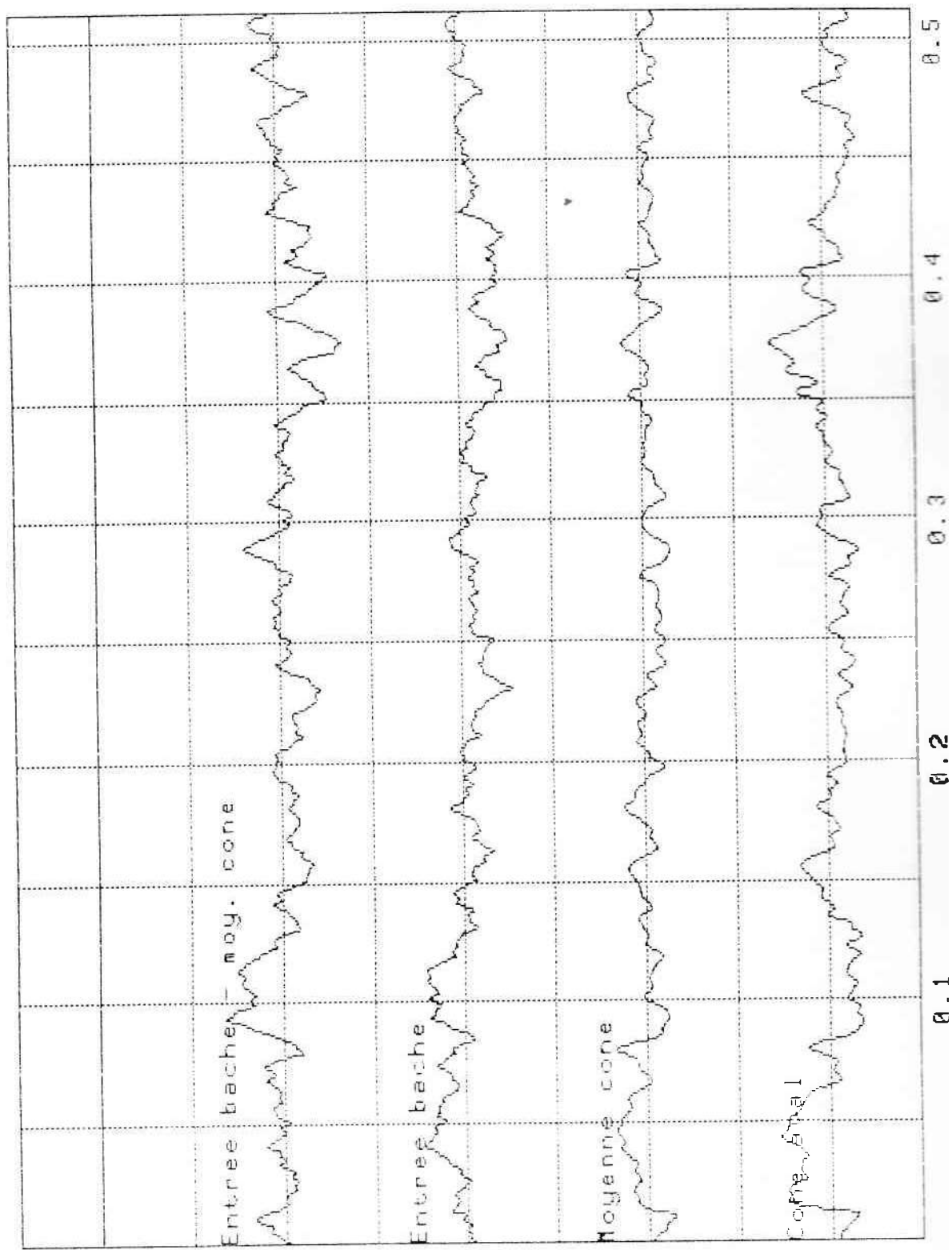
dul:gte009.dat



dul:gte010.dat

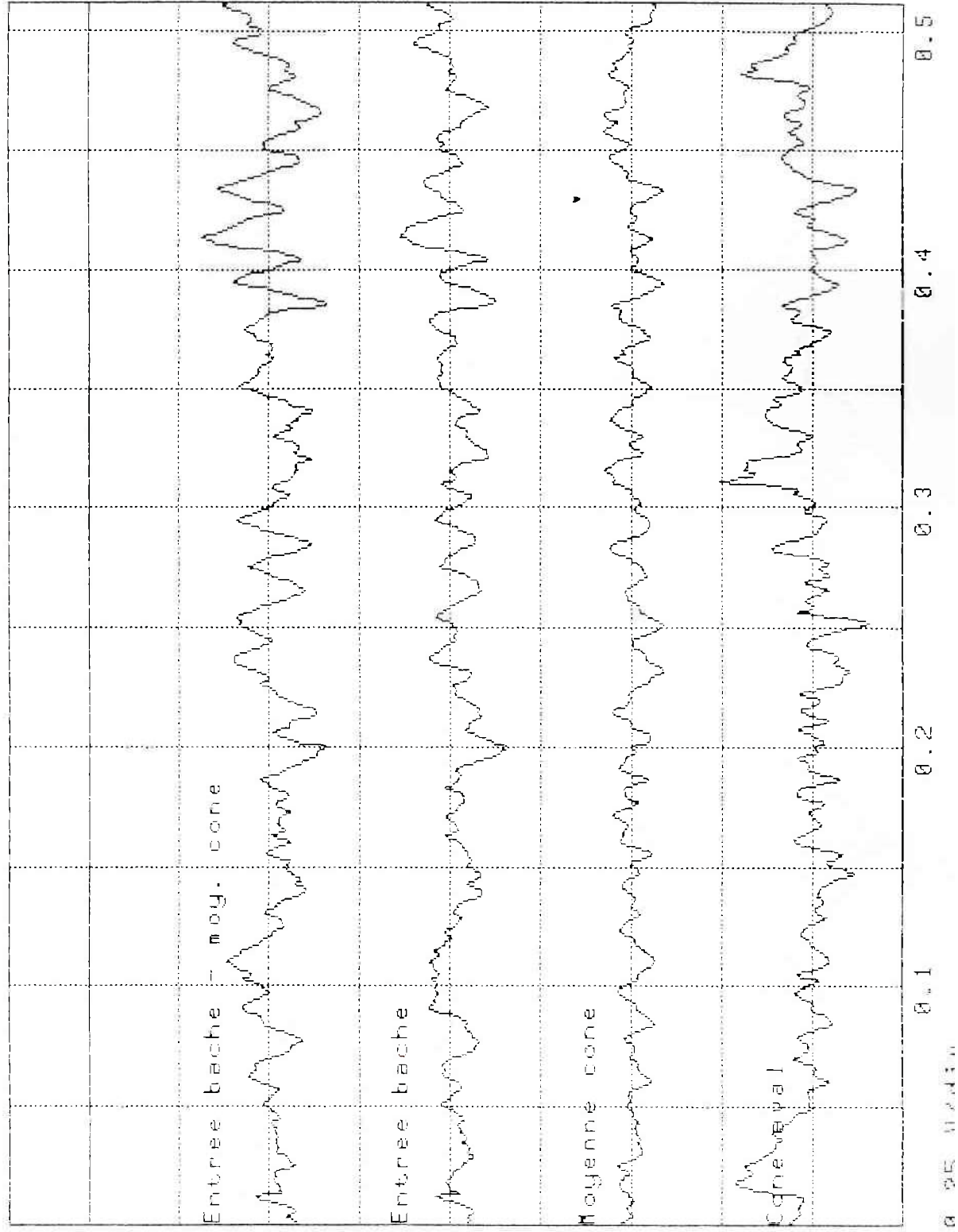


du1:gte011L.dat

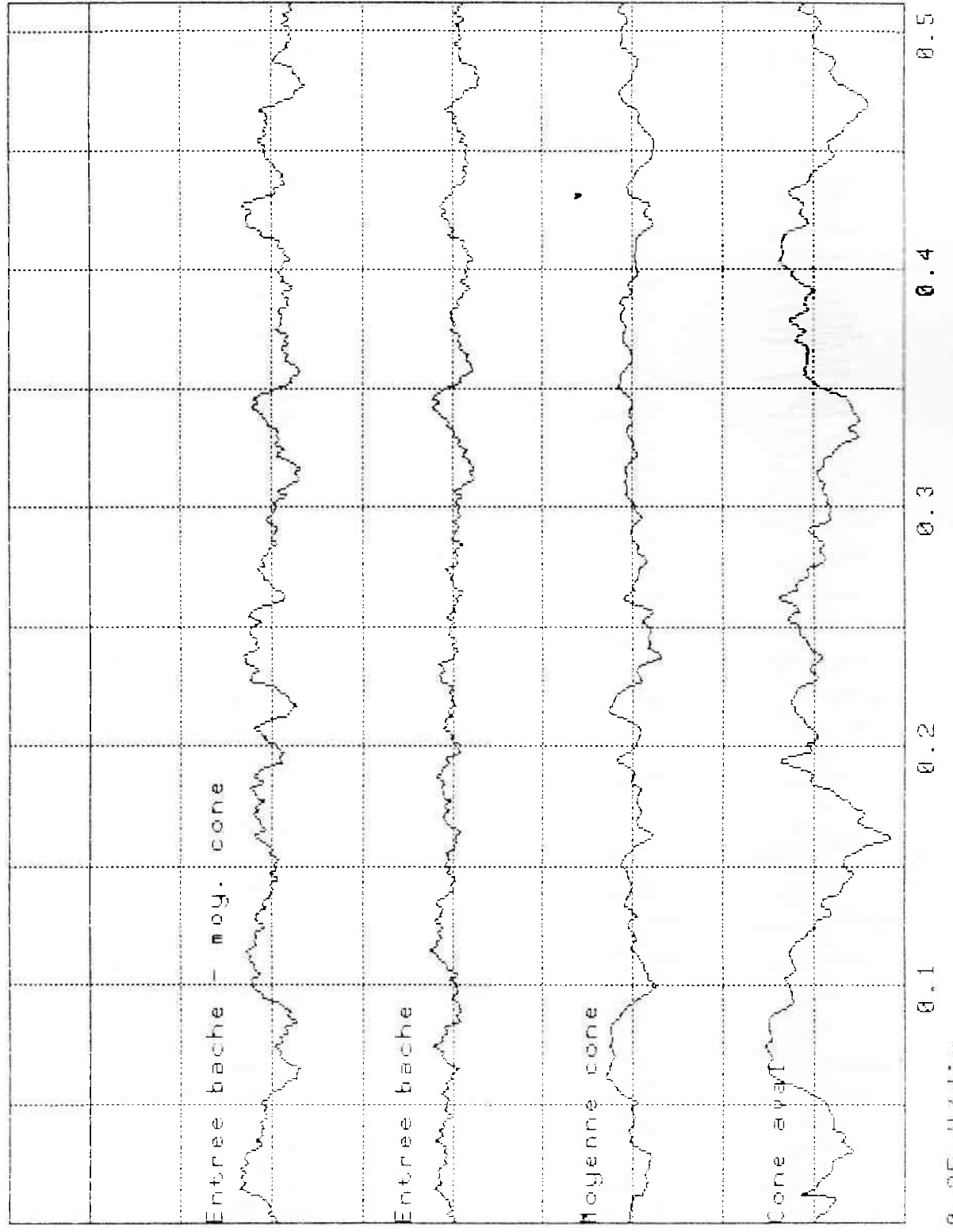




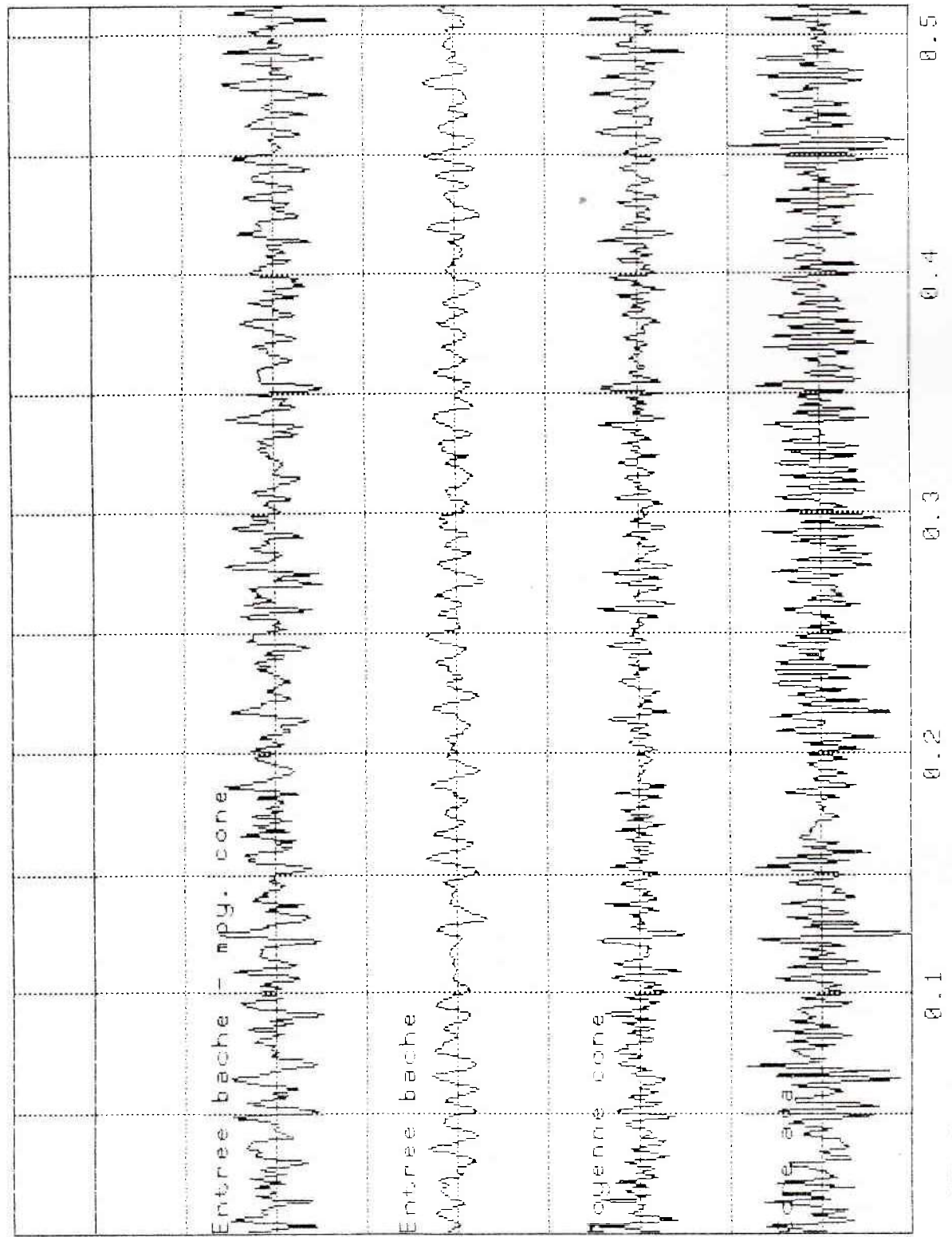
du1:gte012.dat



du1:gte013.dat

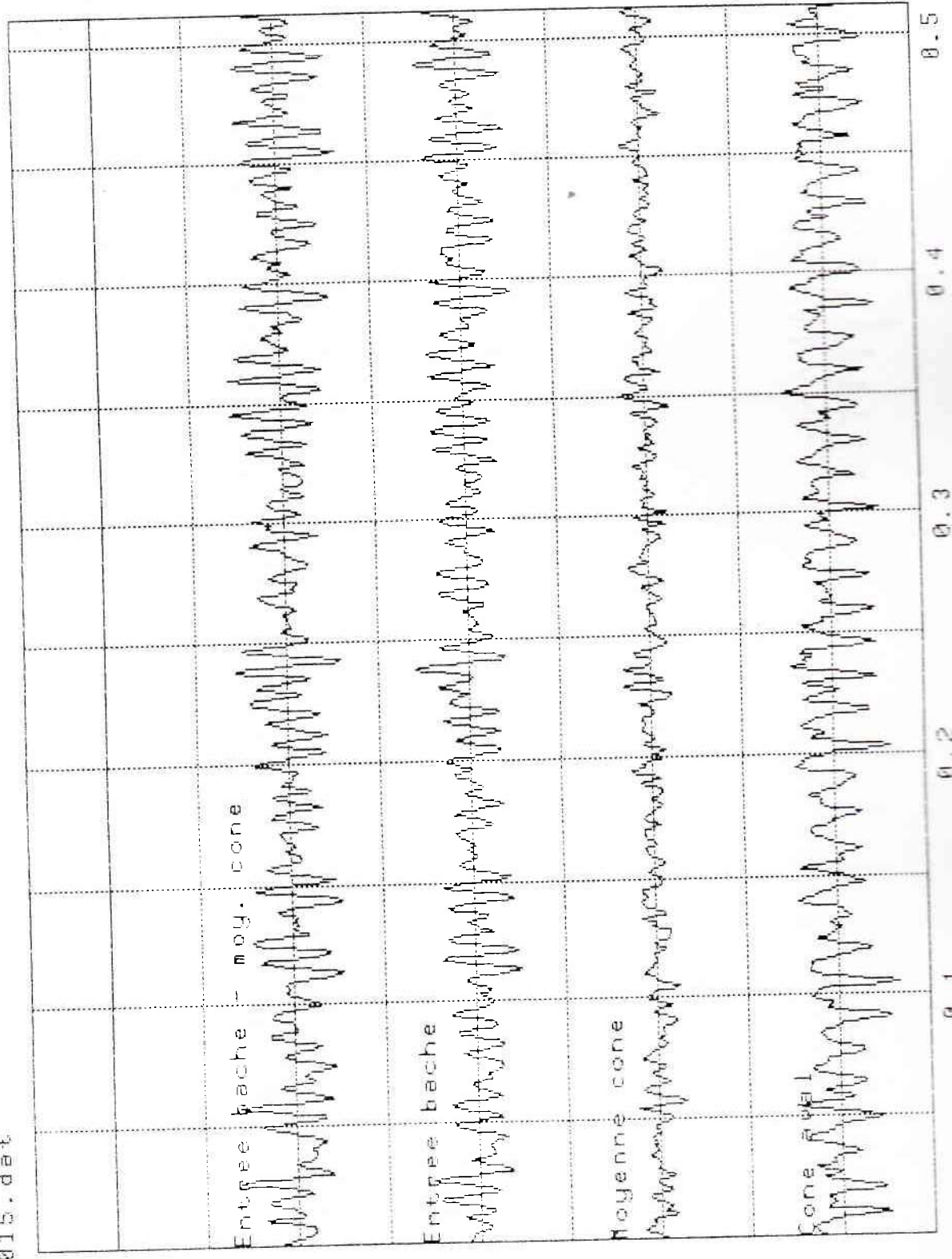


du1:gte014.dat

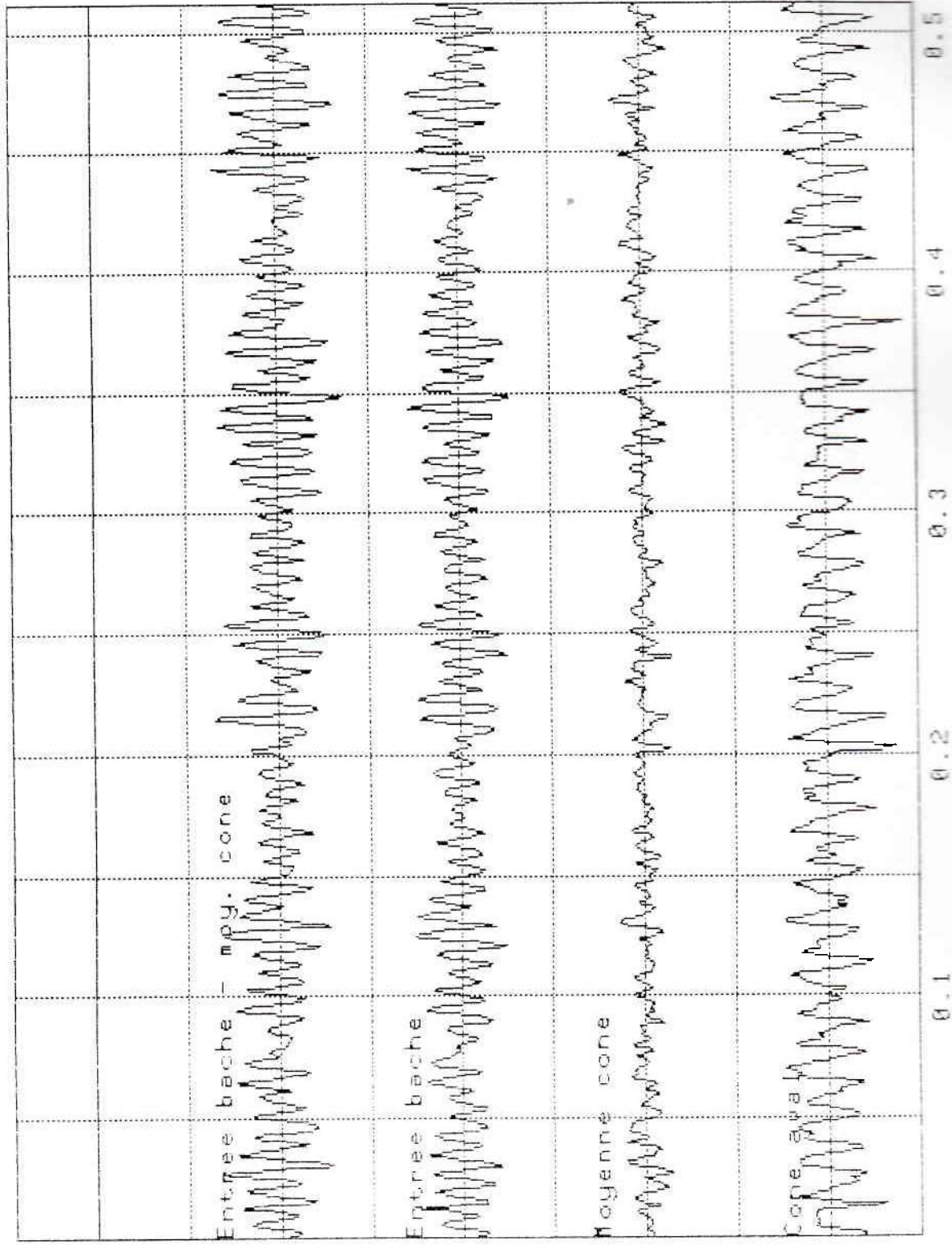




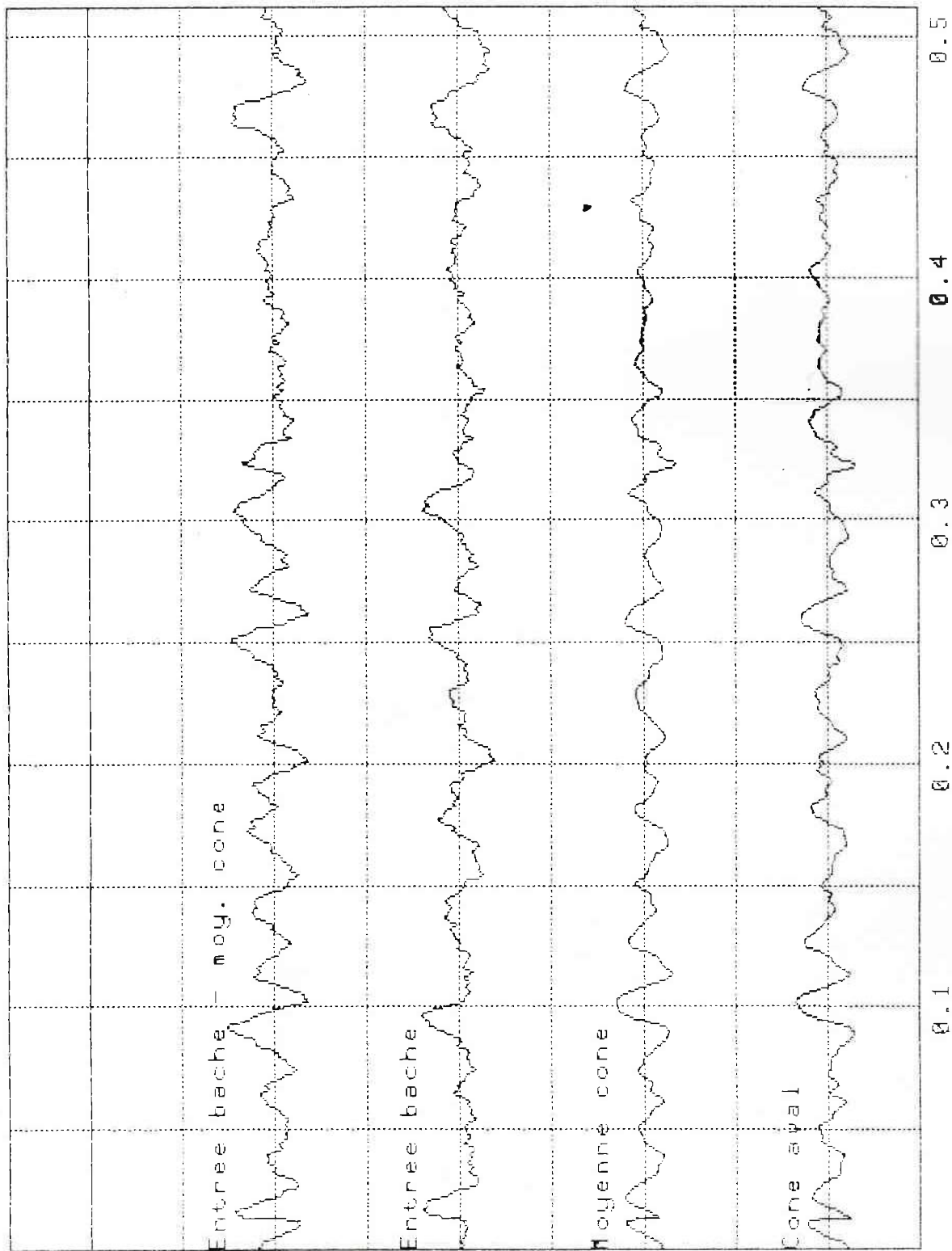
du1:gte015.dat



du1:gte016.dat

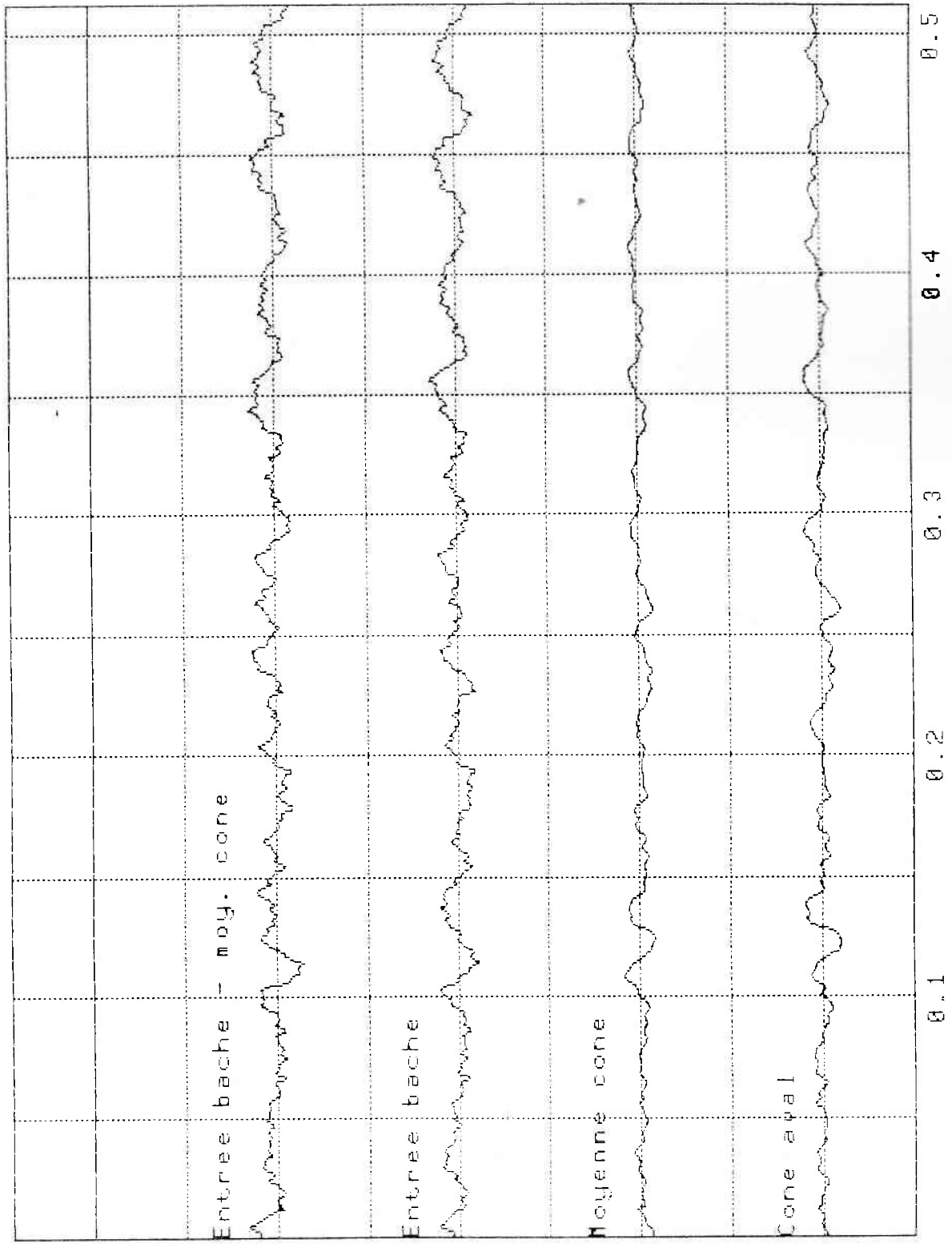


du1:gte017.dat

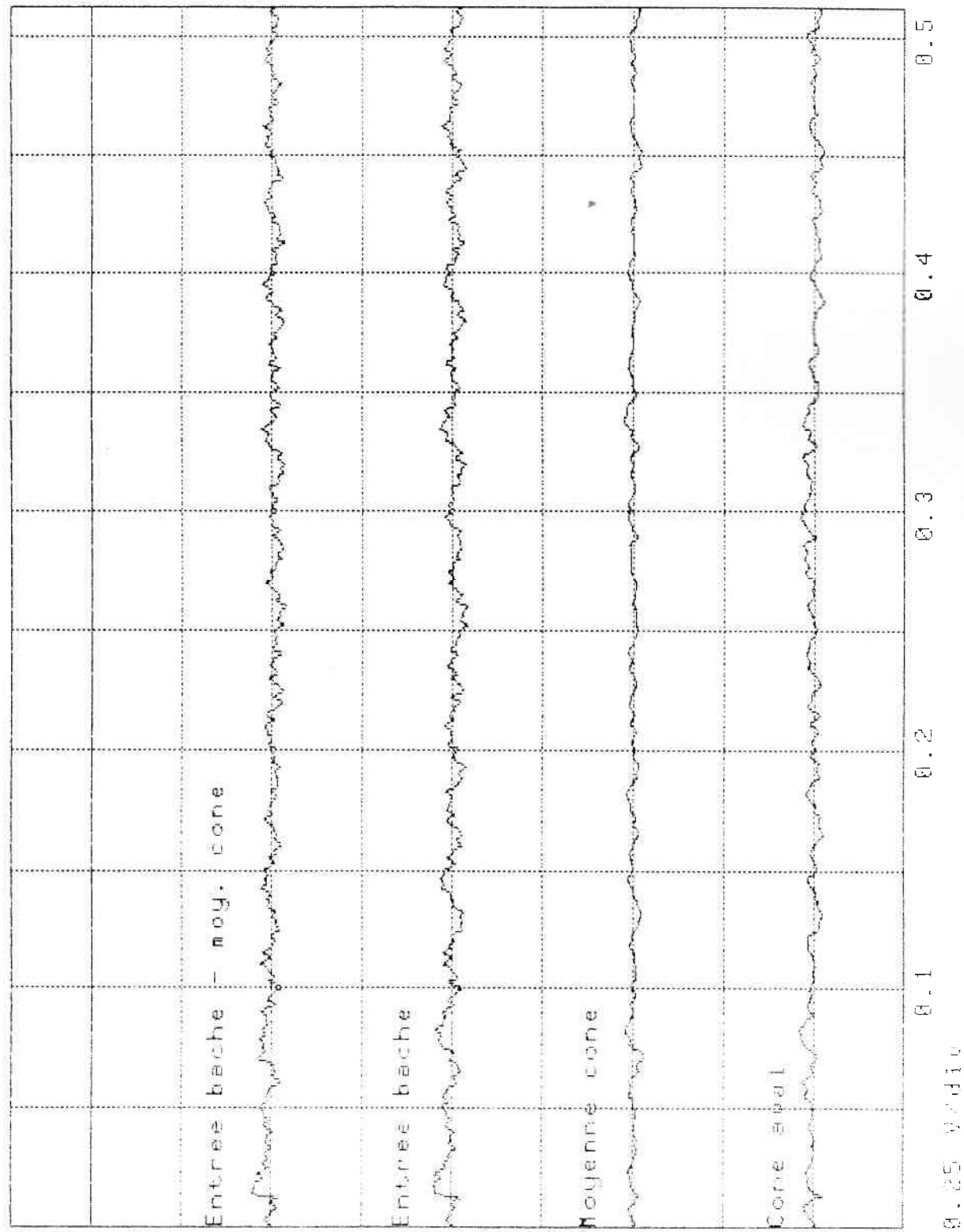




du1:gte018.dat



dul:gte019.dat



***328-05***

***CONTROL  
DIMENSIONAL***



# SECCION DE MEDIDA AGUAS ARRIBA

tomas de presión en conducto maquinado :

D teórico = 548,70 mm

D1 = 548,55 mm

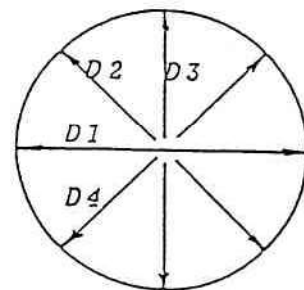
D2 = 548,66 mm

D3 = 548,62 mm

D4 = 548,73 mm

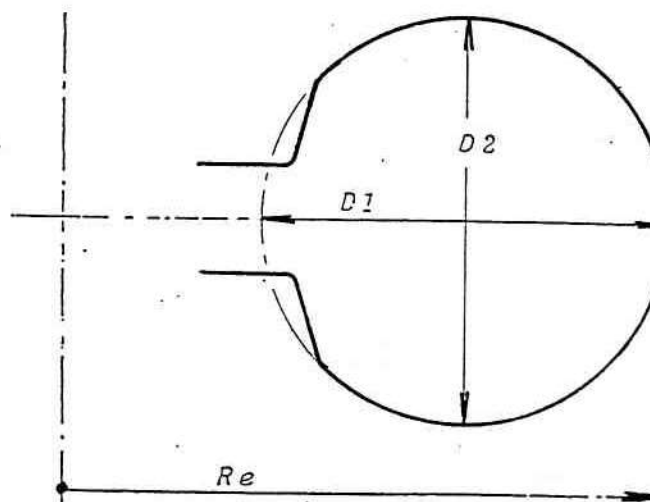
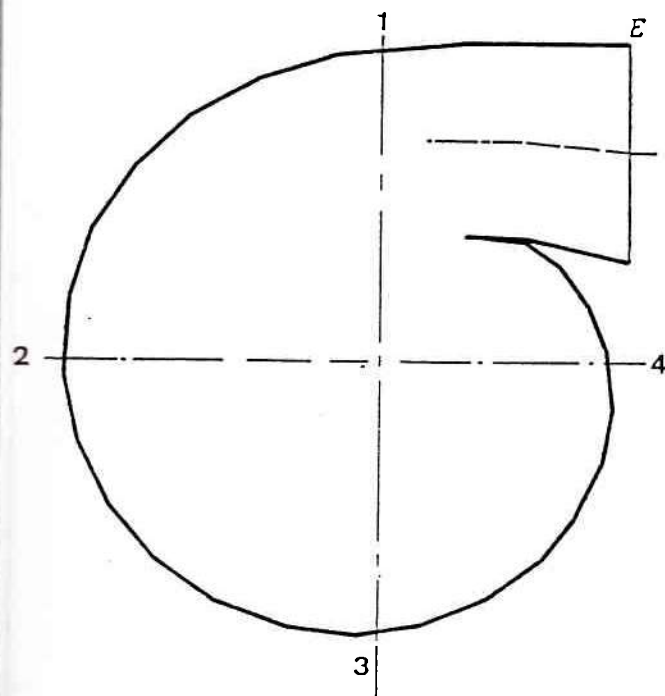
D medio = 548,64 mm

S = 0,23641 m<sup>2</sup>



CAJA ESPIRAL - Planos nº 648 240

Diámetro de la sección de entrada E y diámetro de las secciones 1, 2, 3, y 4



| Sección | D1 mm                               | D2 mm                               | Re mm          |
|---------|-------------------------------------|-------------------------------------|----------------|
| E       | Teórico : 548,70<br>Medido : 548,50 | Teórico : 548,70<br>Medido : 548,95 |                |
| 1       |                                     | Teórico : 275,70<br>Medido : 275,5  | 851,80<br>853  |
| 2       |                                     | Teórico : 243,4<br>Medido : 243,8   | 784<br>783,5   |
| 3       |                                     | Teórico : 202,2<br>Medido : 202,0   | 695,2<br>695,5 |
| 4       |                                     | Teórico : 147,4<br>Medido : 147,4   | 569,4<br>568,5 |

por EDF 12

por NP Rucchi

por IMHEF G. Litti

CONTROL DIMENSIONAL DEL MODELO DE GABRIEL TERRA

Por UTE

*[Signature]*

*[Signature]*

Tabla 1

ANTEDISTRIBUIDOR - Altura del paso hidraulico -  $H_{AVD}$  teorica = 142,40

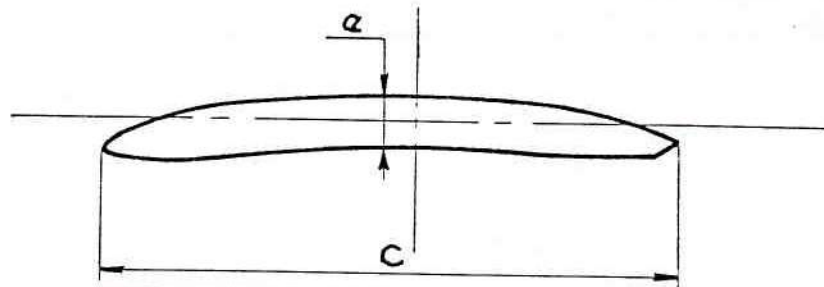
$H_{AVD}$  medida entre los alabes fijos n°

|                 | y 2   | y 5   | y 8   | y 11  |
|-----------------|-------|-------|-------|-------|
| A la entrada mm | 177   | 177,5 | 177   | 177,6 |
| A la salida mm  | 142,3 | 142,5 | 142,0 | 142,0 |

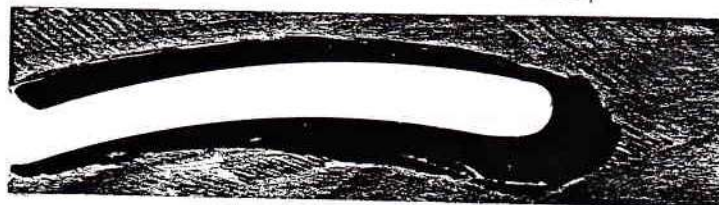
Medida media = 142,2 mm - Desviacion = 0,14 %

Perfil de los alabes fijos - Planos 648 244

Se podran presentar 2 plantillas, extrados e intrados, sobre la seccion mediana de los alabes fijos.



seccion de  
un alabe



aguas  
abajo

Expesor teorico :  $e =$   
Longitud teorica :  $c = 72,90$

| Medidas tomadas en los alabes fijos n° |       |      |              |      |
|--|-------|------|--------------|------|
|  | 2     | 5    | 8            | 11   |
| Espesor e mm                           |       |      |              |      |
| Longitud c mm                          | 73,1  | 73,0 | 72,9         | 72,9 |
| Medida media mm                        |       |      | Desviacion % |      |
| Espesor e mm                           |       |      |              |      |
| Longitud c mm                          | 72,98 |      |              | 0,1  |

CONTROL DIMENSIONAL DEL MODELO DE GABRIEL TERRA

Tabla n° 2

pour EDF

12

pour UTE

*[Firma]*

*[Firma]*

pour NP

*[Firma]*

pour IMHEF

*[Firma]*

DISTRIBUTOR - Altura del paso hidraulico -  $H_D$  teorica = 141

| $H_D$ medida entre los alabes moviles n° |       |       |       |       |
|--|-------|-------|-------|-------|
|  | y 1   | y 7   | y 13  | y 19  |
| A la entrada mm                          |       |       |       |       |
| A la salida mm                           | 141,2 | 141,1 | 141,2 | 141,1 |

Medida media = 141,15 mm - Desviacion 0,11 %

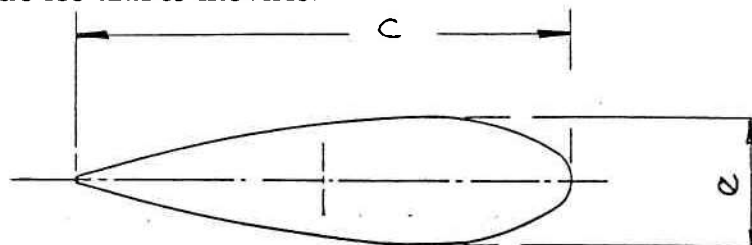
Huelgo entre alabe movil y tapa

| Huelgo en mm medido entre los alabes moviles n° |      |      |      |      |
|---|------|------|------|------|
| y la tapa                                       | 1    | 7    | 13   | 19   |
| superior  | 0,06 | 0,02 | 0,05 | 0,08 |
| inferior  | 0,21 | 0,17 | 0,21 | 0,06 |

Huelgo medido = 0,11 mm

Perfil de los alabes moviles - Plano n° 648 251

Se podran presentar 2 plantillas, intrados sobre la seccion mediana de los alabes moviles.



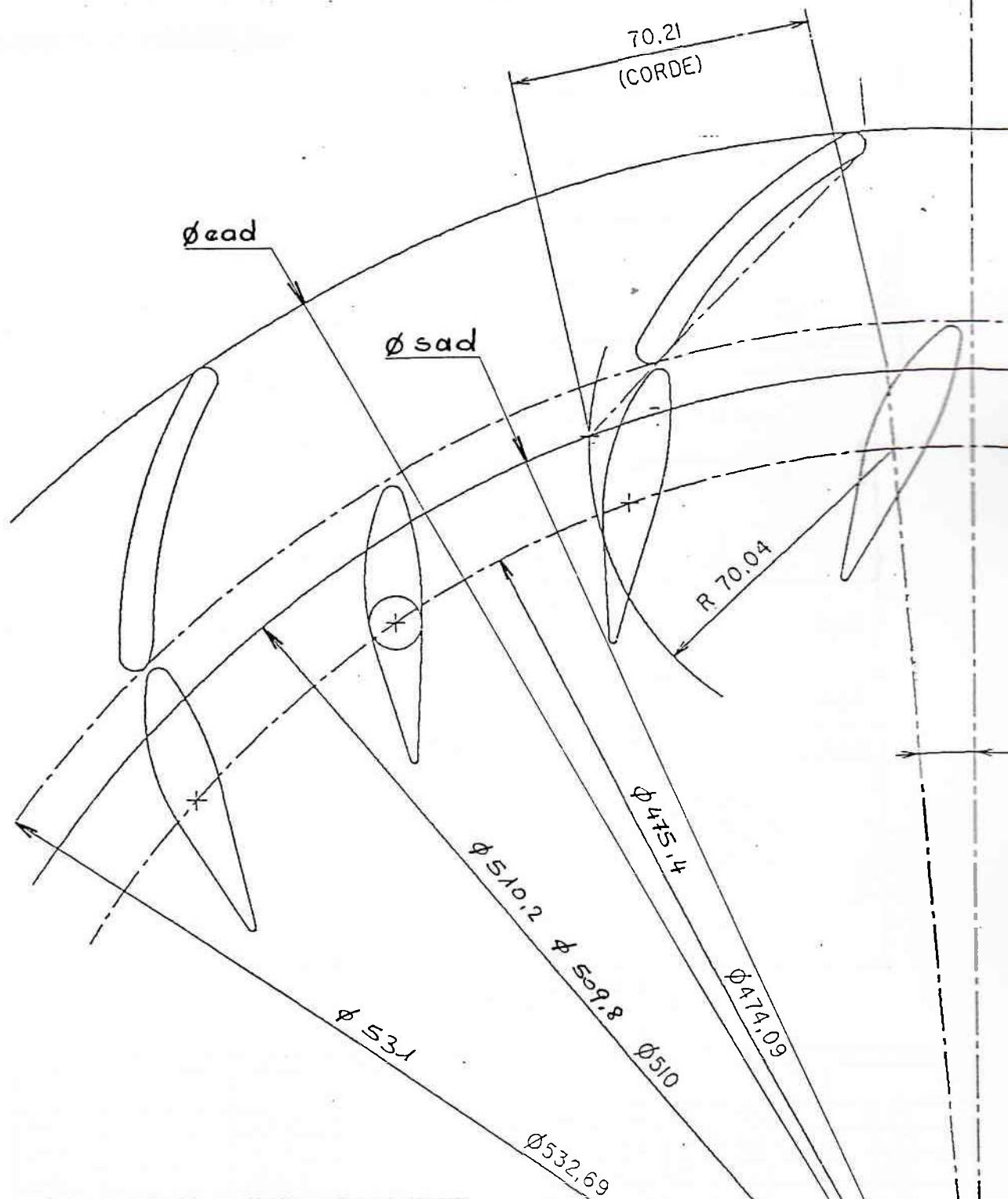
Espesor maximo teorico : e = 13,45  
 Longitud teorica : c = 65,02  
 a teorico :  
 b teorico :

| medidas en mm tomadas en los alabes moviles n° |       |       |       |       |
|--|-------|-------|-------|-------|
|  | 1     | 7     | 13    | 18    |
| espesor e                                      | 13,54 | 13,40 | 13,53 | 13,44 |
| Longitud c                                     | 65,1  | 64,9  | 65,05 | 65,09 |
| a  |       |       |       |       |
| b  |       |       |       |       |





# POSICION RELATIVA ANTEDISTR. - DISTR.



| CUERDA | Medida mm | Desviación mm |
|--------|-----------|---------------|
| R      | 70,1      | +0,06         |

1 am EDF

12

pour NP

*Signature*

pour IMHEF

*Signature*

CONTROL DIMENSIONAL DEL MODELO DE GABRIEL TERRA

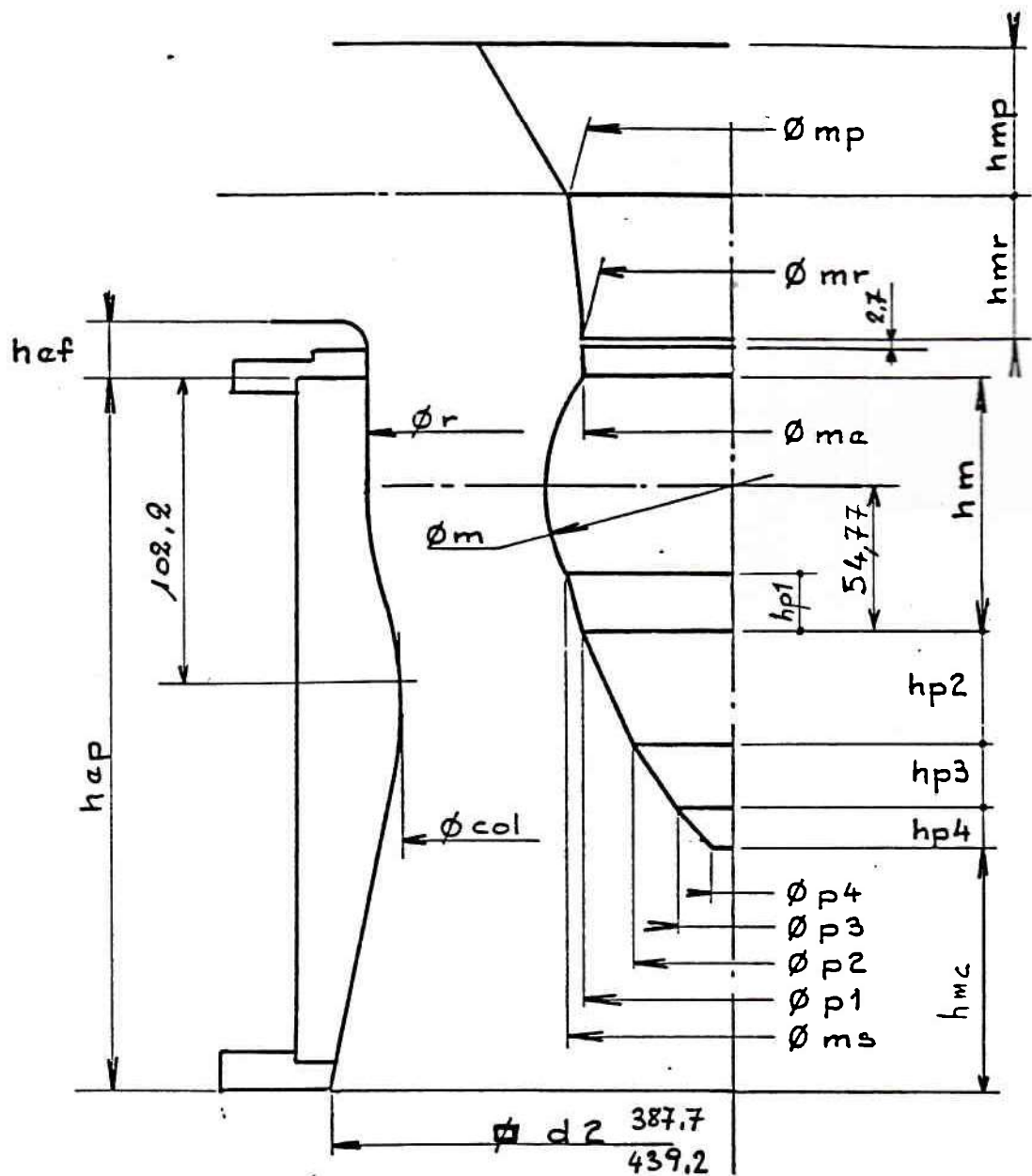
P. U. T. E.

*Signature*

*Signature*

Tabla

# CONDUCTO MERIDIANO KAPLAN



|     | Teorico | Medido | Deviation% |
|-----|---------|--------|------------|
| hmp |         | 67,7   |            |
| hmr |         | 67,7   |            |
| Ømp |         | 185,4  |            |
| Ømr | 153,3   | 153,2  | 0,07       |
| hm  | 92,86   | 92,96  | 0,11       |
| hp1 | 16      | 15,1   | 5,63       |
| hp2 | 29,78   | 31     | 4,1        |
| hp3 | 50,95   | 53     | 4,02       |
| hp4 | 26,26   | 23     | 12,41      |
| Øme | 144,22  | 144,29 | 0,05       |
| Øm  | 163,43  | 163,48 | 0,03       |

|      | Teoric      | Medidio      | Deviation% |
|------|-------------|--------------|------------|
| Øms  | 144,22      | 144,1        | 0,08       |
| Øp1  | 139,64      | 139,6 (roue) | 0,03       |
| Øp2  | 124,63      | 124,6        | 0,02       |
| Øp3  | 77,6        | 76,0         | 2,06       |
| Øp4  | 47,03       | 48,0         | 2,06       |
| hef  | 47          | 47,0         | 0          |
| hep  | 253         | 253,0        | 0          |
| Ør   | 380         | 380,21       | 0,06       |
| Øcol | 369,2       | 369,32       | 0,03       |
| Ød2  | 387,3-439,6 | 387,7-439,2  | 0,1 x 0,09 |
| hmc  | 53,14       | 52,3         | 1,58       |

Mesures plexi effectuées à T = 23 (°C)

CONTROL DIMENSIONAL DEL MODELO DE GABRIEL TERRA

Tabla 5

pour EDF  
+2

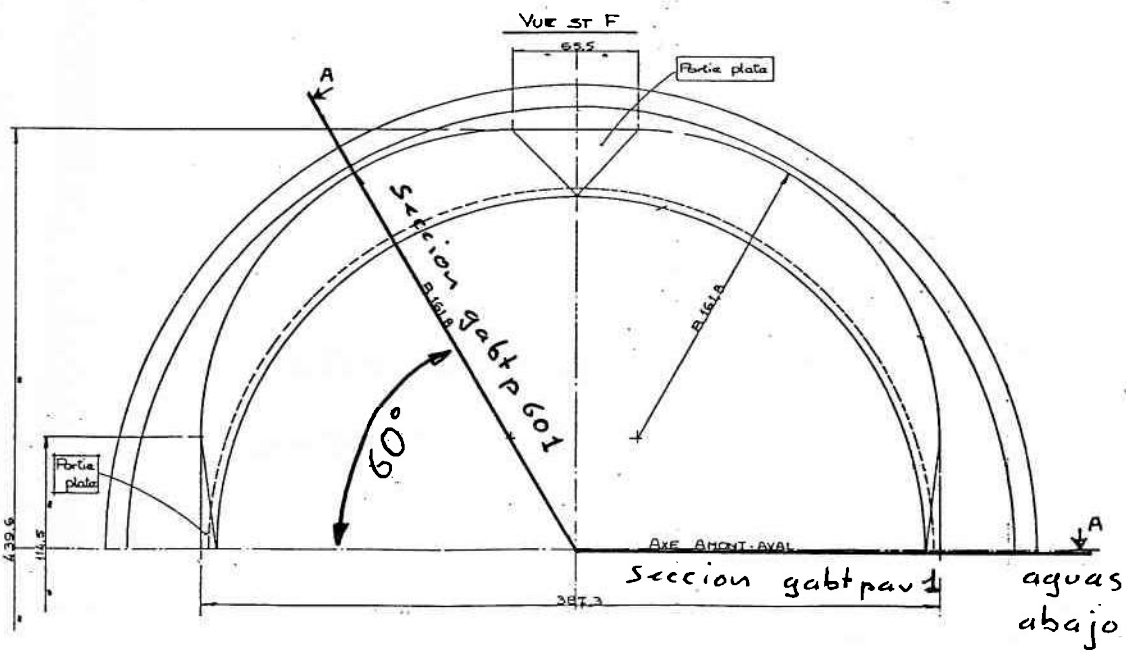
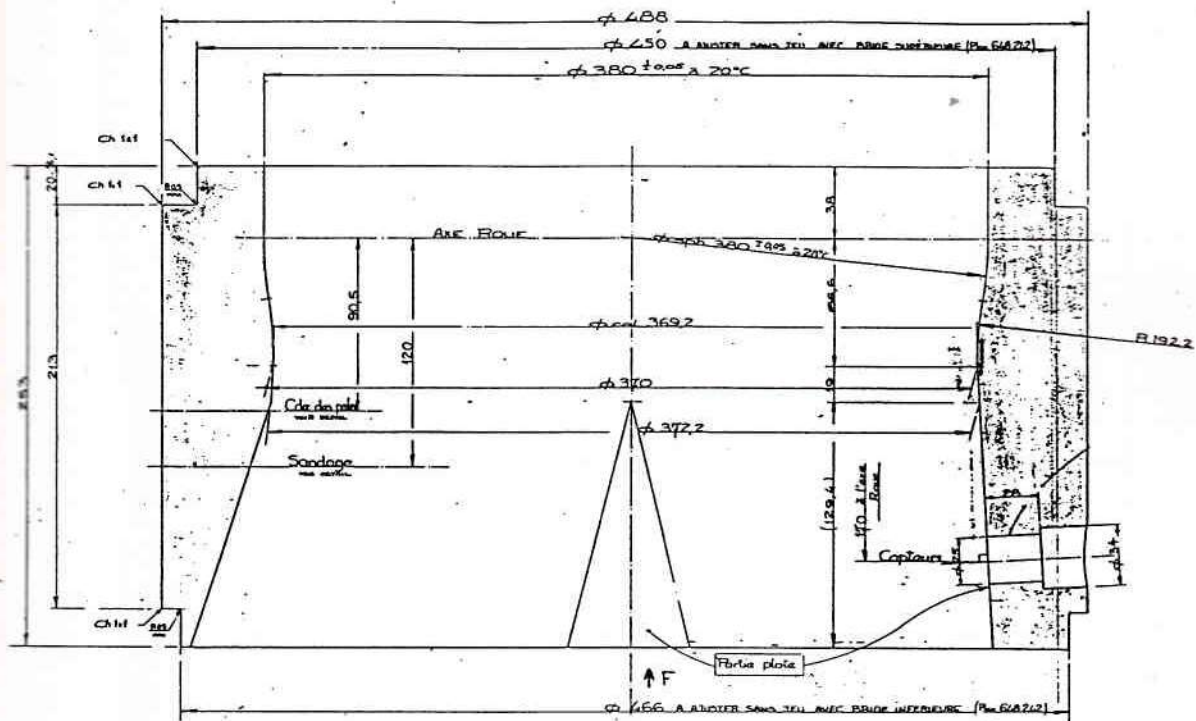
pour UTE  
Gabriel Terra

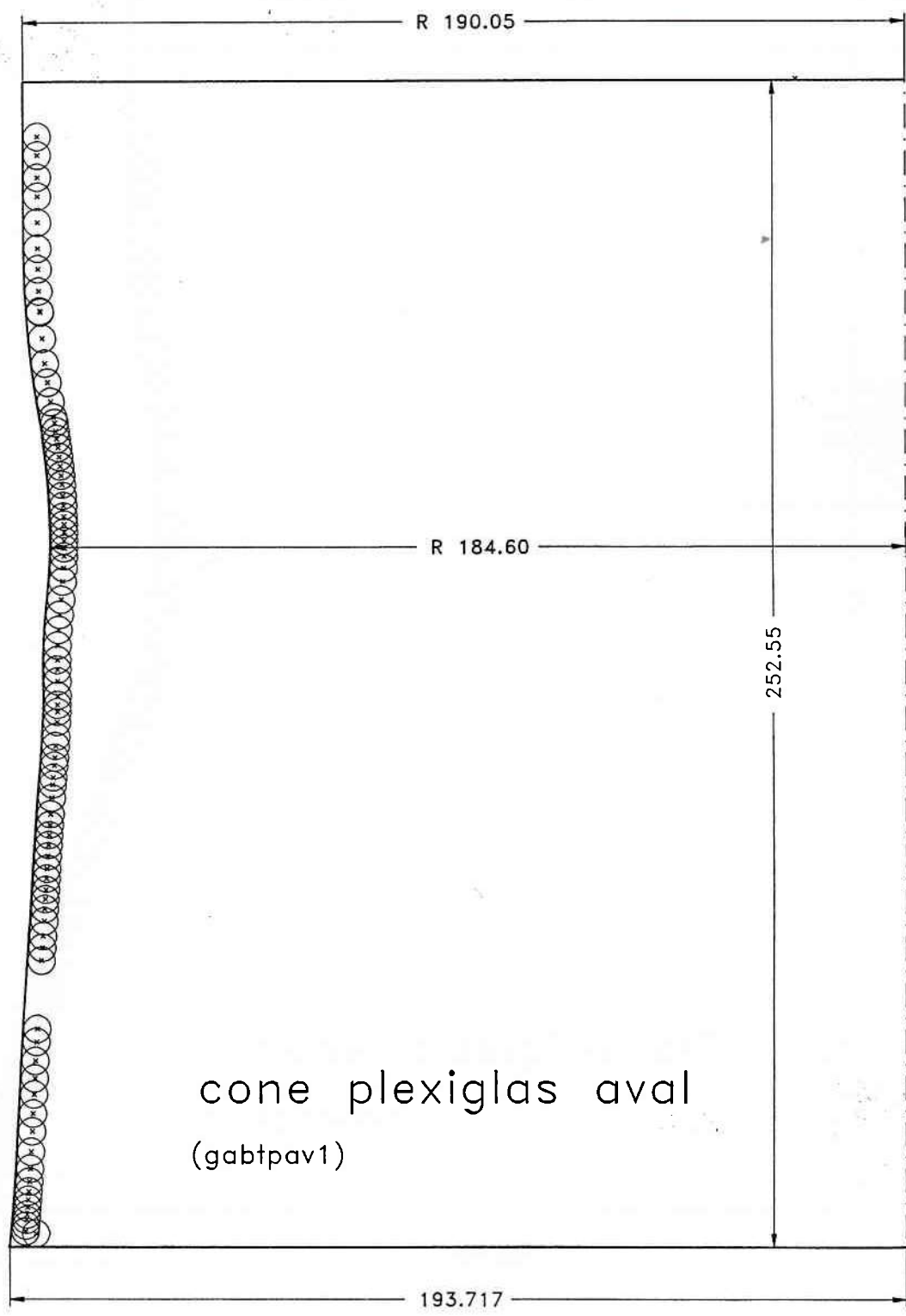
pour NP  
Pierrelle

pour IMHEF  
S. Liti

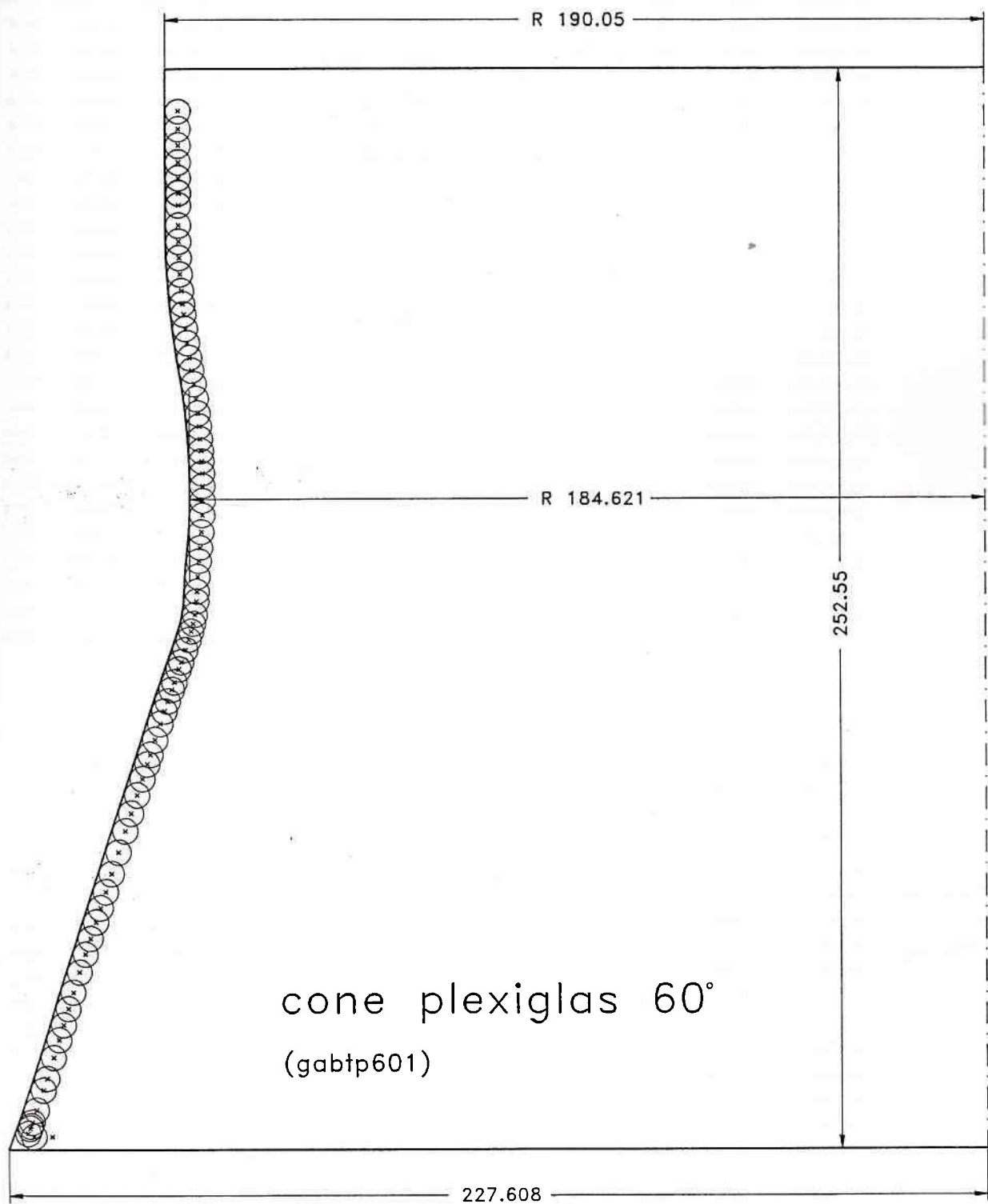


Coupe AA





cone plexiglas aval  
(gabtpav1)





UPE gabpay

| X (mm) | Y (mm)   | Z (mm)  | N  |
|--------|----------|---------|----|
| 8.478  | -163.512 | -12.350 | 4  |
| 8.478  | -163.516 | -16.354 | 5  |
| 8.478  | -163.512 | -21.130 | 6  |
| 8.478  | -163.510 | -25.236 | 7  |
| 8.478  | -163.516 | -30.782 | 8  |
| 8.478  | -163.516 | -36.382 | 9  |
| 8.478  | -163.468 | -40.810 | 10 |
| 8.478  | -163.322 | -45.634 | 11 |
| 8.478  | -163.088 | -49.946 | 12 |
| 8.478  | -163.024 | -50.232 | 13 |
| 8.478  | -162.606 | -55.872 | 14 |
| 8.478  | -162.024 | -61.208 | 15 |
| 8.478  | -161.474 | -65.318 | 16 |
| 8.478  | -160.838 | -69.418 | 17 |
| 8.478  | -160.266 | -72.760 | 18 |
| 8.478  | -160.008 | -73.938 | 19 |
| 8.478  | -159.774 | -75.734 | 20 |
| 8.478  | -159.550 | -77.394 | 21 |
| 8.478  | -159.310 | -79.280 | 22 |
| 8.478  | -159.082 | -81.254 | 23 |
| 8.478  | -158.866 | -83.270 | 24 |
| 8.478  | -158.674 | -85.302 | 25 |
| 8.478  | -158.516 | -87.278 | 26 |
| 8.478  | -158.354 | -89.722 | 27 |
| 8.478  | -158.242 | -91.890 | 28 |

Jan EDF 12  
 For UTE Wausley  
 9-04-92

For IHHEF  
Wausley  
 For NP Wausley

|       |          |          |    |
|-------|----------|----------|----|
| 8.478 | -158.156 | -94.216  | 29 |
| 8.478 | -158.110 | -95.930  | 30 |
| 8.478 | -158.078 | -97.682  | 31 |
| 8.478 | -158.060 | -99.588  | 32 |
| 8.478 | -158.062 | -101.246 | 33 |
| 8.478 | -158.080 | -102.954 | 34 |
| 8.478 | -158.166 | -105.538 | 35 |
| 8.478 | -158.354 | -108.482 | 36 |
| 8.478 | -158.694 | -112.404 | 37 |
| 8.478 | -159.004 | -115.676 | 38 |
| 8.478 | -159.298 | -118.930 | 39 |
| 8.478 | -159.512 | -122.322 | 40 |
| 8.478 | -159.576 | -125.464 | 41 |
| 8.478 | -159.572 | -127.524 | 42 |
| 8.478 | -159.550 | -130.066 | 43 |
| 8.478 | -159.536 | -133.220 | 44 |
| 8.478 | -159.552 | -135.186 | 45 |
| 8.478 | -159.586 | -136.718 | 46 |
| 8.478 | -159.680 | -138.962 | 47 |
| 8.478 | -159.884 | -142.152 | 48 |
| 8.478 | -160.040 | -144.198 | 49 |
| 8.478 | -160.248 | -146.774 | 50 |
| 8.478 | -160.386 | -148.490 | 51 |
| 8.478 | -160.606 | -151.136 | 52 |
| 8.478 | -160.734 | -152.698 | 53 |
| 8.478 | -160.960 | -155.618 | 54 |
| 8.478 | -161.216 | -159.222 | 55 |
| 8.478 | -161.368 | -161.540 | 56 |
| 8.478 | -161.514 | -163.832 | 57 |
| 8.478 | -161.648 | -165.998 | 58 |
| 8.478 | -161.802 | -168.456 | 59 |

9-04-92

Jan EDF 12  
 For UTE Wausley

Wausley  
Wausley

|       |          |          |    |
|-------|----------|----------|----|
| 8.478 | -161.970 | -171.160 | 60 |
| 8.478 | -162.098 | -173.294 | 61 |
| 8.478 | -162.244 | -175.756 | 62 |
| 8.478 | -162.370 | -177.776 | 63 |
| 8.478 | -162.518 | -179.872 | 64 |
| 8.478 | -162.714 | -182.564 | 65 |
| 8.478 | -162.646 | -182.564 | 66 |
| 8.478 | -162.940 | -185.764 | 67 |
| 8.478 | -163.092 | -188.272 | 68 |
| 8.478 | -163.270 | -191.022 | 69 |
| 8.478 | -164.186 | -205.744 | 70 |
| 8.478 | -164.356 | -208.524 | 71 |
| 8.478 | -164.580 | -212.630 | 72 |
| 8.478 | -164.748 | -216.406 | 73 |
| 8.478 | -164.912 | -219.900 | 74 |
| 8.478 | -165.142 | -224.028 | 75 |
| 8.478 | -165.336 | -227.870 | 76 |
| 8.478 | -165.574 | -232.270 | 77 |
| 8.478 | -165.794 | -235.954 | 78 |
| 8.478 | -165.978 | -238.722 | 79 |
| 8.478 | -166.130 | -240.864 | 80 |
| 8.478 | -166.268 | -242.662 | 81 |
| 8.478 | -166.404 | -244.274 | 82 |
| 8.478 | -166.542 | -245.864 | 83 |
| 8.478 | -166.640 | -246.982 | 84 |
| 8.478 | -166.756 | -248.250 | 85 |
| 8.478 | -166.874 | -249.458 | 86 |
| 8.478 | -166.880 | -249.526 | 87 |
| 8.478 | -164.570 | -249.960 | 88 |
| 8.478 | -161.658 | -249.960 | 89 |
| 8.478 | -158.012 | -249.964 | 90 |

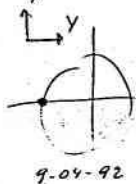
9-04-92

Jan EDF 12  
 For UTE Wausley

Wausley  
Wausley

COUPE: gabtp60

| X (mm) | Y (mm)   | Z (mm)  | N  |
|--------|----------|---------|----|
| -3.675 | -171.606 | -10.222 | 4  |
| -3.675 | -171.602 | -14.398 | 5  |
| -3.675 | -171.602 | -18.196 | 6  |
| -3.675 | -171.606 | -22.120 | 7  |
| -3.675 | -171.610 | -25.770 | 8  |
| -3.675 | -171.612 | -29.242 | 9  |
| -3.675 | -171.570 | -29.242 | 10 |
| -3.675 | -171.614 | -32.070 | 11 |
| -3.675 | -171.620 | -36.772 | 12 |
| -3.675 | -171.578 | -40.552 | 13 |
| -3.675 | -171.474 | -44.336 | 14 |
| -3.675 | -171.294 | -48.182 | 15 |
| -3.675 | -171.038 | -52.080 | 16 |
| -3.675 | -170.784 | -55.110 | 17 |
| -3.675 | -170.546 | -57.502 | 18 |
| -3.675 | -170.154 | -60.934 | 19 |
| -3.675 | -169.726 | -64.226 | 20 |
| -3.675 | -169.218 | -67.682 | 21 |
| -3.675 | -168.732 | -70.634 | 22 |
| -3.675 | -168.182 | -73.754 | 23 |
| -3.675 | -167.680 | -77.180 | 24 |
| -3.675 | -167.272 | -80.562 | 25 |
| -3.675 | -166.972 | -83.558 | 26 |
| -3.675 | -166.724 | -86.502 | 27 |
| -3.675 | -166.518 | -89.316 | 28 |



10m EDF *[Signature]*  
 12m UTE *[Signature]*  
*Wolucien*

10m IHHEF  
*[Signature]*  
 12m NT *[Signature]*  
*Wolucien*

|        |          |          |    |
|--------|----------|----------|----|
| -3.675 | -187.942 | -188.552 | 60 |
| -3.675 | -189.300 | -192.732 | 61 |
| -3.675 | -190.508 | -196.464 | 62 |
| -3.675 | -191.574 | -199.754 | 63 |
| -3.675 | -192.830 | -203.610 | 64 |
| -3.675 | -194.034 | -207.290 | 65 |
| -3.675 | -195.426 | -211.496 | 66 |
| -3.675 | -196.996 | -216.230 | 67 |
| -3.675 | -198.226 | -220.088 | 68 |
| -3.675 | -199.416 | -223.902 | 69 |
| -3.675 | -200.518 | -227.410 | 70 |
| -3.675 | -201.850 | -231.612 | 71 |
| -3.675 | -203.422 | -236.508 | 72 |
| -3.675 | -204.318 | -239.220 | 73 |
| -3.675 | -205.902 | -243.892 | 74 |
| -3.675 | -206.870 | -246.646 | 75 |
| -3.675 | -207.190 | -247.530 | 76 |
| -3.675 | -207.380 | -248.054 | 77 |
| -3.675 | -207.812 | -249.222 | 78 |
| -3.675 | -206.448 | -249.960 | 79 |
| -3.675 | -202.198 | -249.962 | 80 |
| -3.675 | -196.090 | -249.964 | 81 |
| -3.675 | -187.160 | -249.960 | 82 |
| -3.675 | -176.526 | -249.948 | 83 |
| -3.675 | -163.612 | -249.962 | 84 |
| -3.675 | -153.910 | -249.958 | 85 |
| -3.675 | -139.584 | -249.958 | 86 |
| -3.675 | -127.106 | -249.956 | 87 |
| -3.675 | -117.480 | -249.962 | 88 |
| -3.675 | -103.842 | -249.958 | 89 |

9-04-92

10m EDF *[Signature]*  
 12m UTE *[Signature]*  
*Wolucien*  
*[Signature]*  
*[Signature]*

|        |          |          |    |
|--------|----------|----------|----|
| -3.675 | -166.380 | -91.728  | 29 |
| -3.675 | -166.264 | -94.624  | 30 |
| -3.675 | -166.198 | -97.598  | 31 |
| -3.675 | -166.178 | -101.120 | 32 |
| -3.675 | -166.244 | -104.598 | 33 |
| -3.675 | -166.470 | -108.612 | 34 |
| -3.675 | -166.788 | -112.382 | 35 |
| -3.675 | -167.094 | -115.576 | 36 |
| -3.675 | -167.412 | -119.290 | 37 |
| -3.675 | -167.616 | -122.840 | 38 |
| -3.675 | -167.746 | -125.154 | 39 |
| -3.675 | -168.130 | -128.350 | 40 |
| -3.675 | -168.556 | -130.458 | 41 |
| -3.675 | -169.044 | -132.294 | 42 |
| -3.675 | -169.664 | -134.274 | 43 |
| -3.675 | -170.462 | -136.644 | 44 |
| -3.675 | -171.458 | -139.528 | 45 |
| -3.675 | -172.040 | -141.212 | 46 |
| -3.675 | -173.088 | -144.222 | 47 |
| -3.675 | -173.686 | -145.948 | 48 |
| -3.675 | -174.618 | -148.678 | 49 |
| -3.675 | -175.396 | -150.980 | 50 |
| -3.675 | -176.378 | -153.884 | 51 |
| -3.675 | -177.638 | -157.574 | 52 |
| -3.675 | -178.792 | -160.976 | 53 |
| -3.675 | -179.534 | -163.152 | 54 |
| -3.675 | -180.712 | -166.606 | 55 |
| -3.675 | -181.986 | -170.366 | 56 |
| -3.675 | -183.406 | -174.586 | 57 |
| -3.675 | -184.730 | -178.658 | 58 |
| -3.675 | -186.328 | -183.588 | 59 |

9-04-92

10m EDF *[Signature]*  
 12m UTE *[Signature]*  
*Wolucien*  
*[Signature]*  
*[Signature]*

|       |          |          |    |
|-------|----------|----------|----|
| 8.478 | -153.872 | -249.962 | 91 |
| 8.478 | -149.306 | -249.960 | 92 |
| 8.478 | -143.764 | -249.960 | 93 |
| 8.478 | -138.270 | -249.962 | 94 |
| 8.478 | -127.254 | -249.962 | 95 |
| 8.478 | -121.934 | -249.960 | 96 |
| 8.478 | -113.556 | -249.960 | 97 |
| 8.478 | -105.932 | -249.960 | 98 |

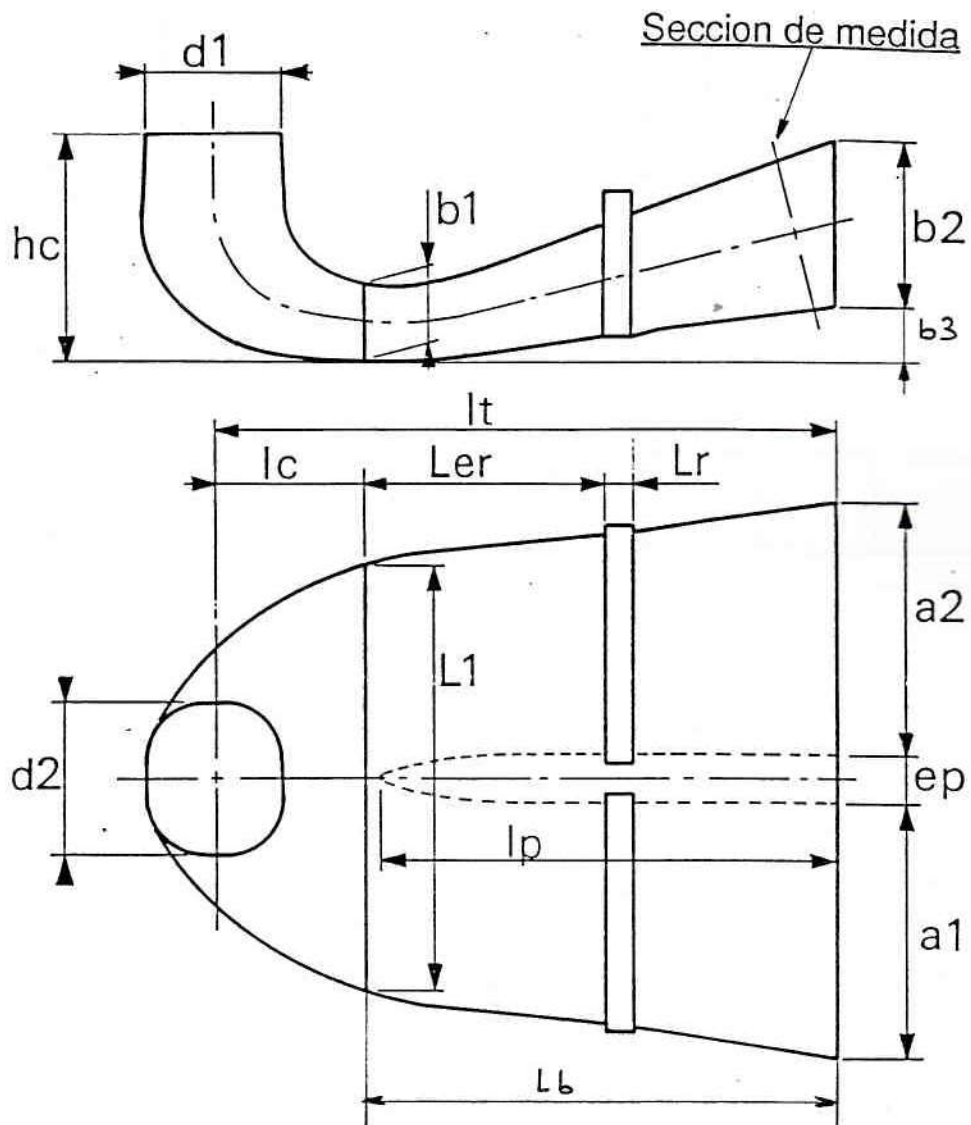
9-04-92

10m EDF *[Signature]*  
 12m UTE *[Signature]*  
*Wolucien*  
*[Signature]*  
*[Signature]*

END

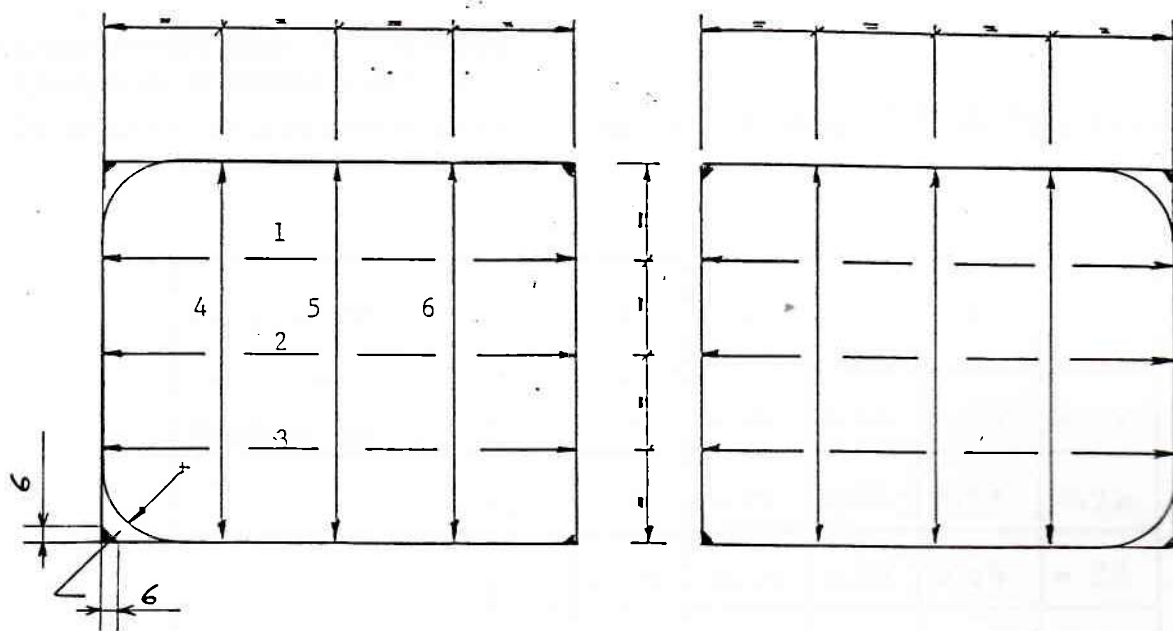
END

# TUBO DE ASPIRACION



|     | cotas teoricas<br>(mm) | cotas medidas<br>(mm) | Desviaciones<br>% |
|-----|------------------------|-----------------------|-------------------|
| d1  | 387,65                 | 387,9                 | 2,52              |
| d2  | 441,04                 | 441,4                 | 0,08              |
| hc  | 644,1                  | 643,0                 | 0,17              |
| lc  | 431,1                  | 425,8                 | 1,23              |
| l1  | 1229                   | 1229,0                | 0                 |
| b1  | 224,2                  | 224,0                 | 0,09              |
| b2  | 479,5                  | 481,5                 | 0,42              |
| lb  | 1379,7                 | 1384,0                | 0,31              |
| lt  | 1810,8                 | 1809,8                | 0,06              |
| lp  | 1336,6                 | 1343,0                | 0,48              |
| ep  | 137,2                  | 138,2                 | 0,73              |
| a1  | 727,1                  | 722,5                 | 0,63              |
| a2  | 727,1                  | 725,5                 | 0,22              |
| Ler | 683,5                  | 690,0                 | 0,95              |
| Lr  | 78,4                   | 78,0                  | 0,51              |
| b3  | 164,2                  | 162,4                 | 1,10              |





|   | Vano izquierdo | Vano derecho |
|---|----------------|--------------|
| 1 | 696,7          | 697,10       |
| 2 | 699,7          | 701,5        |
| 3 | 704,5          | 707,3        |
| 4 | 433,1          | 435,8        |
| 5 | 433,65         | 435,5        |
| 6 | 434,85         | 429,7        |

S

Sección total = 0,6081 m<sup>2</sup>

para EDF  
12

para UTE

para NP  
[Signature]

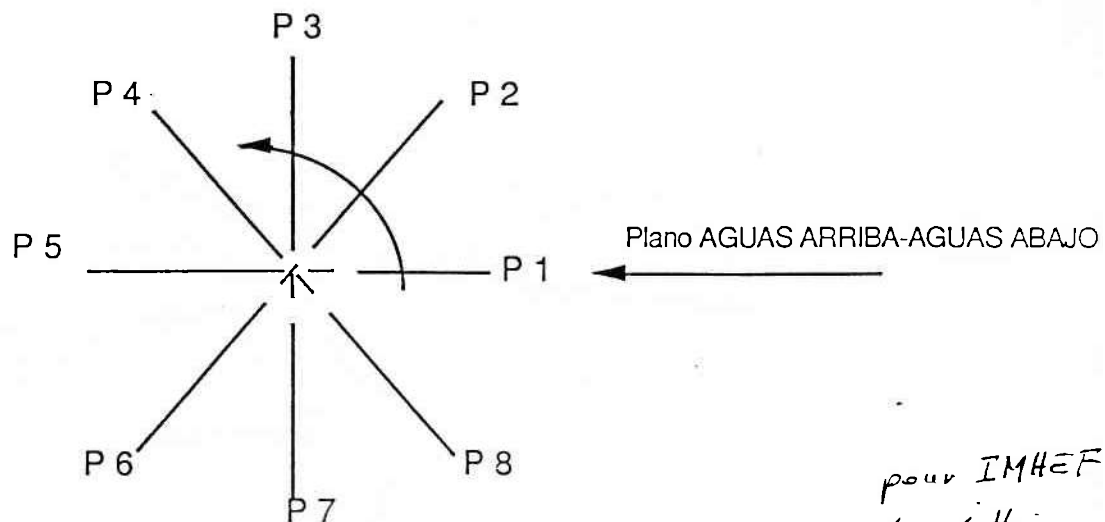
para IMHEF  
G. L. #

## RODETE

- Diametro del cubo = 163,4 mm
- Huelgo entre paletas y cintura
- Inclination de las paletas en grados :  $\alpha_p = 27 \text{ deg}$  ( 9 et  $9\frac{1}{12}$  tours )

| PALETA N°     | 1    | 2    | 3    | 4    | 5    |
|---------------|------|------|------|------|------|
| Huelgos en P1 | 0,13 | 0,18 | 0,35 | 0,25 | 0,18 |
| P2            | 0,12 | 0,14 | 0,32 | 0,28 | 0,20 |
| P3            | 0,15 | 0,12 | 0,27 | 0,29 | 0,23 |
| P4            | 0,18 | 0,12 | 0,23 | 0,26 | 0,27 |
| P5            | 0,20 | 0,17 | 0,22 | 0,20 | 0,25 |
| P6            | 0,21 | 0,18 | 0,26 | 0,19 | 0,21 |
| P7            | 0,20 | 0,20 | 0,27 | 0,18 | 0,18 |
| P8            | 0,14 | 0,19 | 0,30 | 0,25 | 0,17 |

Huelgo medio = 0,21 mm



pour IMHEF  
S. Lott

Control dimensional del modelo de GABRIEL TERRA

Tabla n° 8

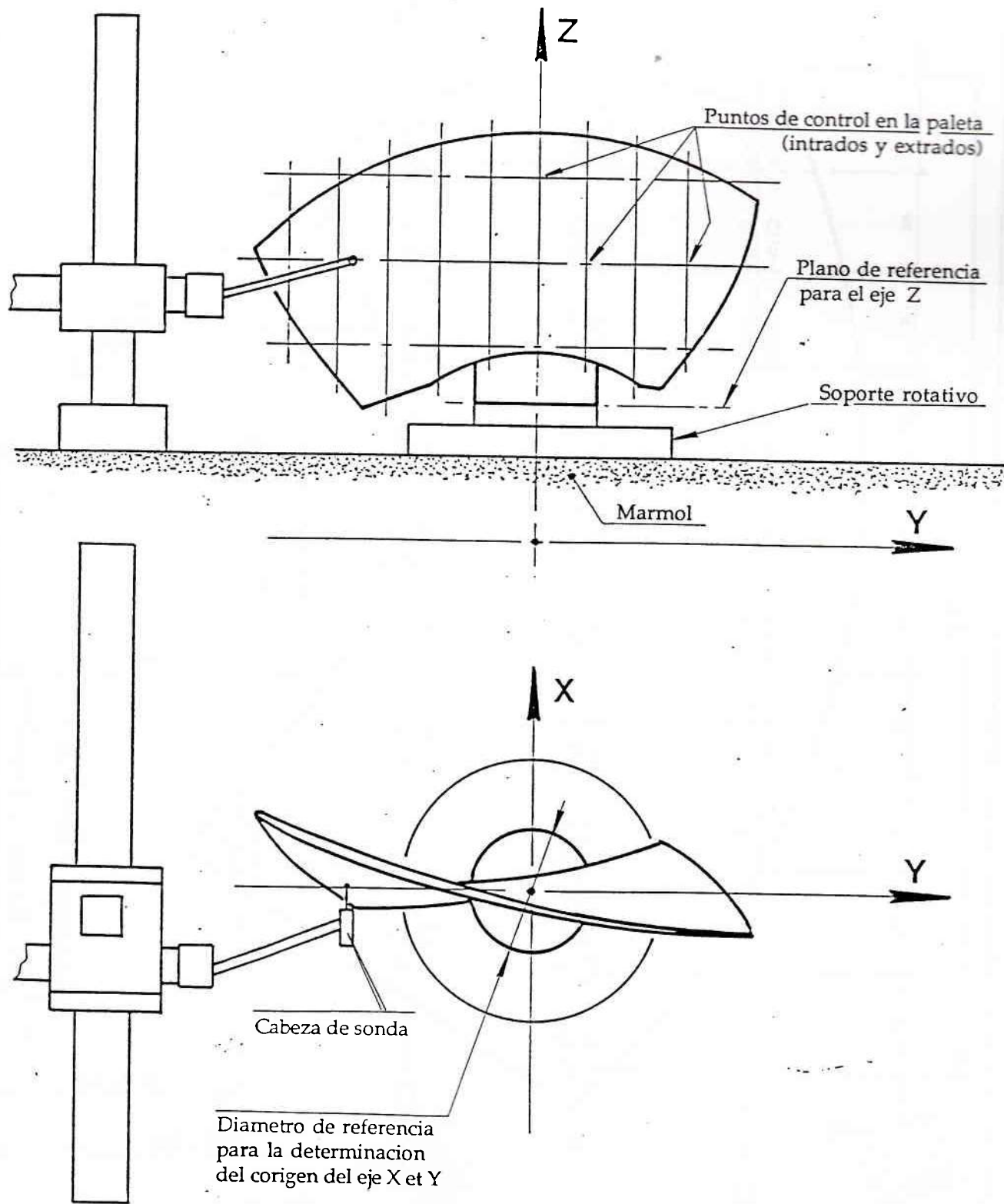
IMHEF  
12

*[Signature]*

*[Signature]*

pour NP  
*[Signature]*

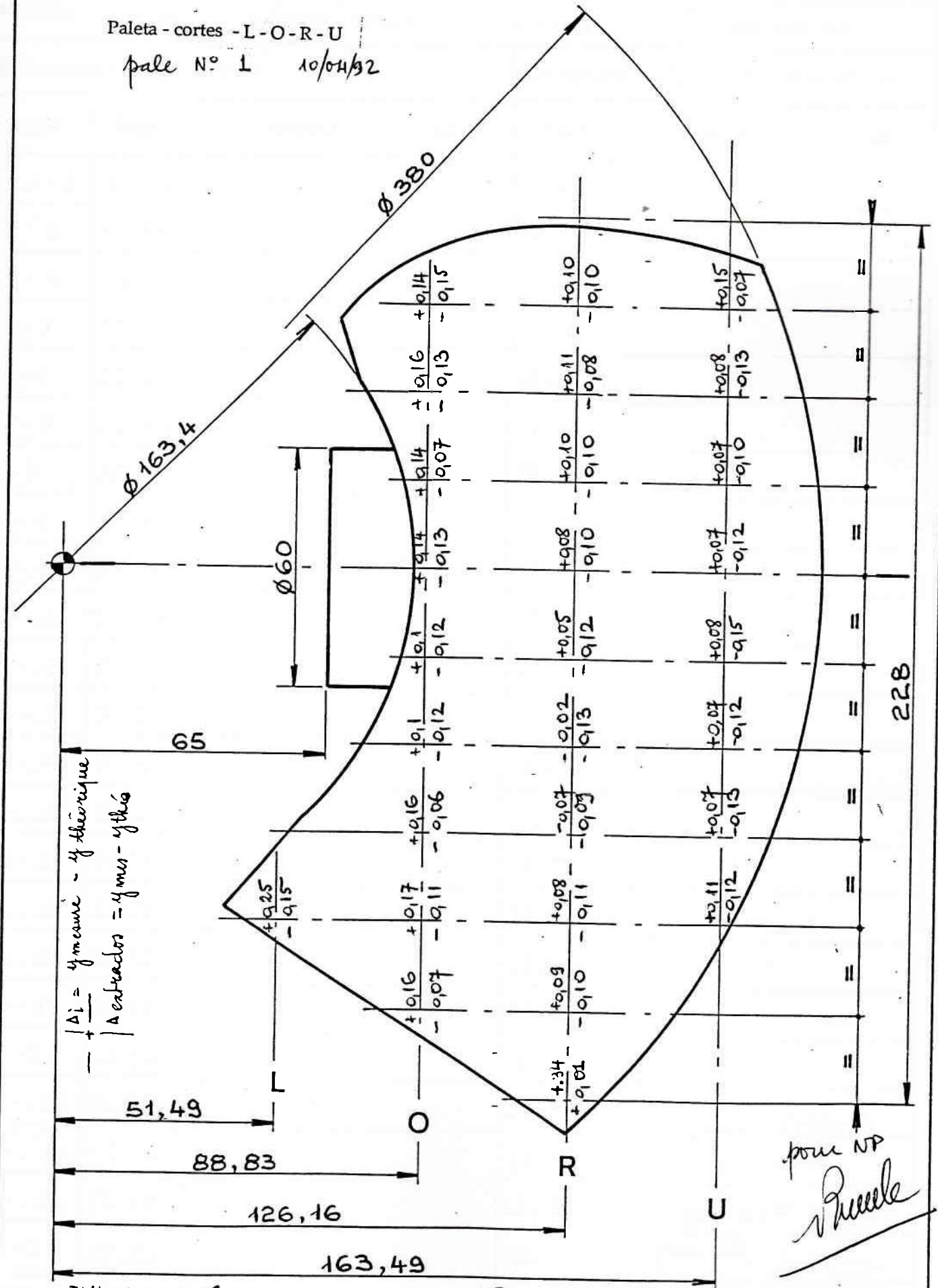
# PRINCIPIO DE CONTROL DE LAS PALETAS





Paleta - cortes - L - O - R - U

pale N° 1 10/04/92



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

## ETALONNAGE DU DISTRIBUTEUR

|  |       |        |               |       |   |     |                 |
|--|-------|--------|---------------|-------|---|-----|-----------------|
| Modèle : 328-00  |       |        | GABRIEL TERRA |       | NEYRPIC   |     | Date: 09 AVR 92 |
| Ouverture : $28^{\circ},4 \rightarrow 28^{\circ},5$ ; $\bar{a} = 25,36$ mm |       |        |               |       | Ouverture : $46^{\circ},6 \rightarrow 46^{\circ},7$ ; $\bar{a} = 38,11$ |     |                 |
| Aube   | haut  | milieu | bas           | haut  | milieu  | bas |                 |
| 1-2  | 25,33 |        |               | 38,02 |   |     |                 |
| 2-3  | 25,36 |        |               | 38,02 |   |     |                 |
| 3-4  | 25,30 |        |               | 38,08 |   |     |                 |
| 4-5  | 25,45 |        |               | 38,15 |   |     |                 |
| 5-6  | 25,30 |        |               | 38,08 |   |     |                 |
| 6-7  | 25,44 |        |               | 38,10 |   |     |                 |
| 7-8  | 25,30 |        |               | 38,07 |   |     |                 |
| 8-9  | 25,49 |        |               | 38,10 |   |     |                 |
| 9-10   | 25,43 |        |               | 38,10 |   |     |                 |
| 10-11  | 25,48 |        |               | 38,16 |   |     |                 |
| 11-12  | 25,39 |        |               | 38,14 |   |     |                 |
| 12-13  | 25,30 |        |               | 38,15 |   |     |                 |
| 13-14  | 25,30 |        |               | 38,12 |   |     |                 |
| 14-15  | 25,32 |        |               | 38,10 |   |     |                 |
| 15-16  | 25,30 |        |               | 38,13 |   |     |                 |
| 16-17  | 25,30 |        |               | 38,12 |   |     |                 |
| 17-18  | 25,35 |        |               | 38,10 |   |     |                 |
| 18-19  | 25,34 |        |               | 38,14 |   |     |                 |
| 19-20  | 25,30 |        |               | 38,08 |   |     |                 |
| 20-21  | 25,35 |        |               | 38,07 |   |     |                 |
| 21-22  | 25,34 |        |               | 38,10 |   |     |                 |
| 22-23  | 25,44 |        |               | 38,18 |   |     |                 |
| 23-24  | 25,32 |        |               | 38,10 |   |     |                 |
| 24-25  | 25,42 |        |               | 38,20 |   |     |                 |

pour IMHEF  
G. Luthi  
pour EDF  
pour ND  
pour UTG

12  
Boule  
C. S. Terra

pour IMHEF

G. Lütj

pour EDF

pour ND

pour UTE

12  
pour  
pour

## GABRIEL TERRA

### Contrôle du pas entre les pales

Le point de référence adopté est l'extrémité de la droite R située sur l'arête d'entrée des pales.

$\left. \begin{matrix} x \\ y \\ z \end{matrix} \right\}$  étant les coordonnées de ce point

l étant la longueur de la droite R

d étant la distance des points de référence sur 2 pales adjacentes.

| N° pale | x        | y         | z       | l      |
|---------|----------|-----------|---------|--------|
| 4       | 110,55   | - 94,180  | 466,954 | 230,31 |
| 5       | 123,544  | + 76,528  | 466,862 | 230,15 |
| 1       | - 34,47  | + 140,860 | 466,796 | 230,19 |
| 3       | - 55,048 | - 134,568 | 466,974 | 230,23 |

$$d(1 - 5) = 170.61$$

$$d(5 - 4) = 171.20$$

$$d(4 - 3) = 170.45$$

pour IHHEF

*HPell*

pour VTE

*Amey Deneux*

pour NP

*Ruebe*

*pour EDF*  
*12*

Grenoble le 10 Avril 1992



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES  
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Essai:

328-00-10 GABRIEL TERRA

NEYRPIC

Date:

08 AVR 92

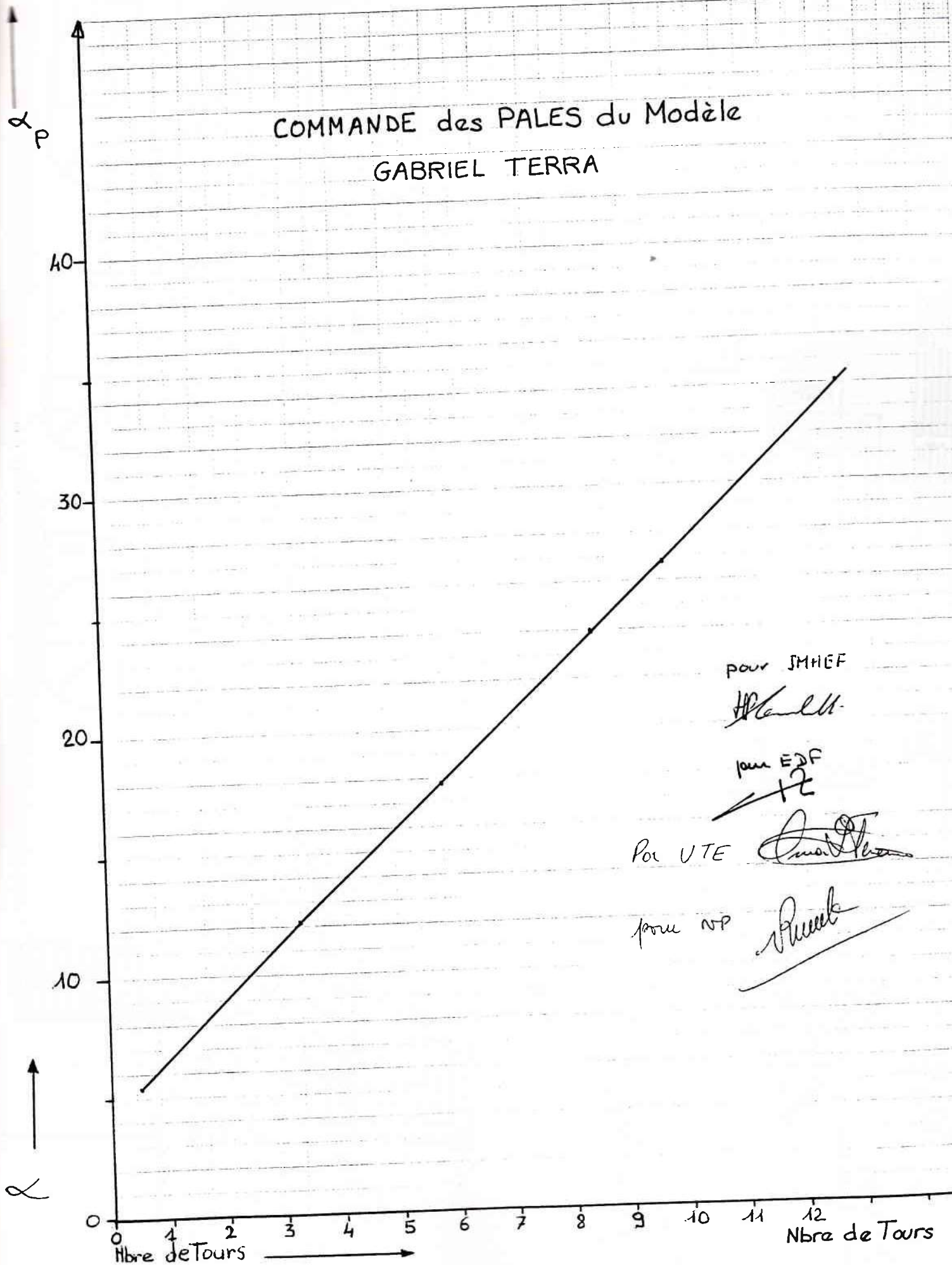
INCLINAISON DES PALES DE LA ROUE 5-KN-35*Courbe utilisée lors des essais.*

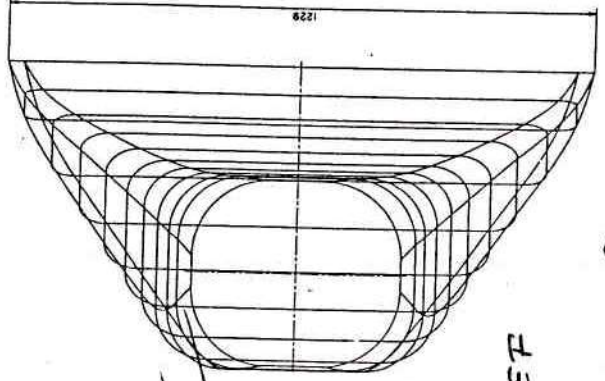
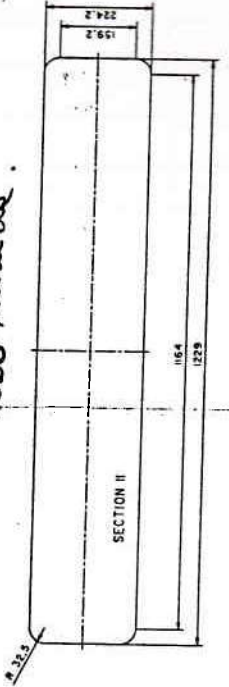
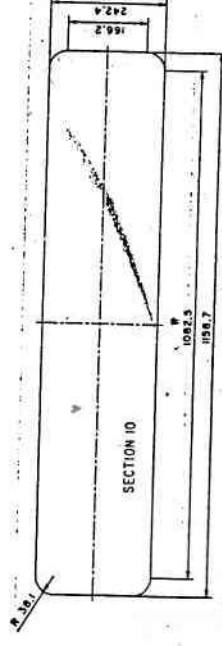
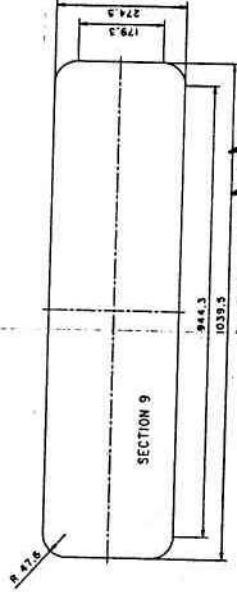
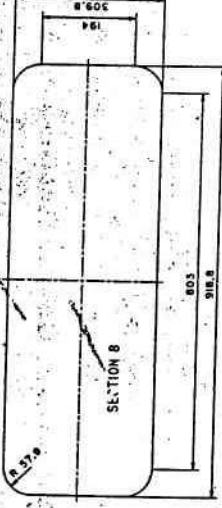
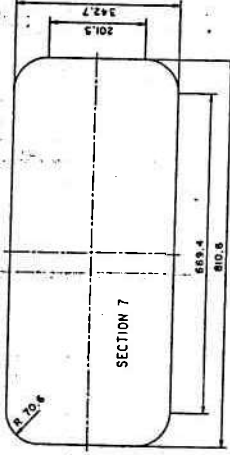
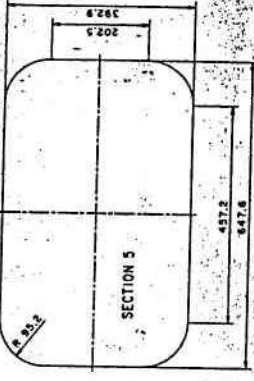
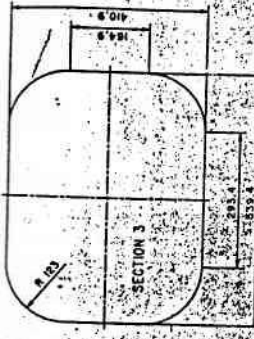
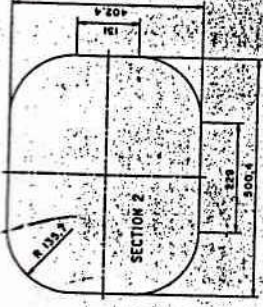
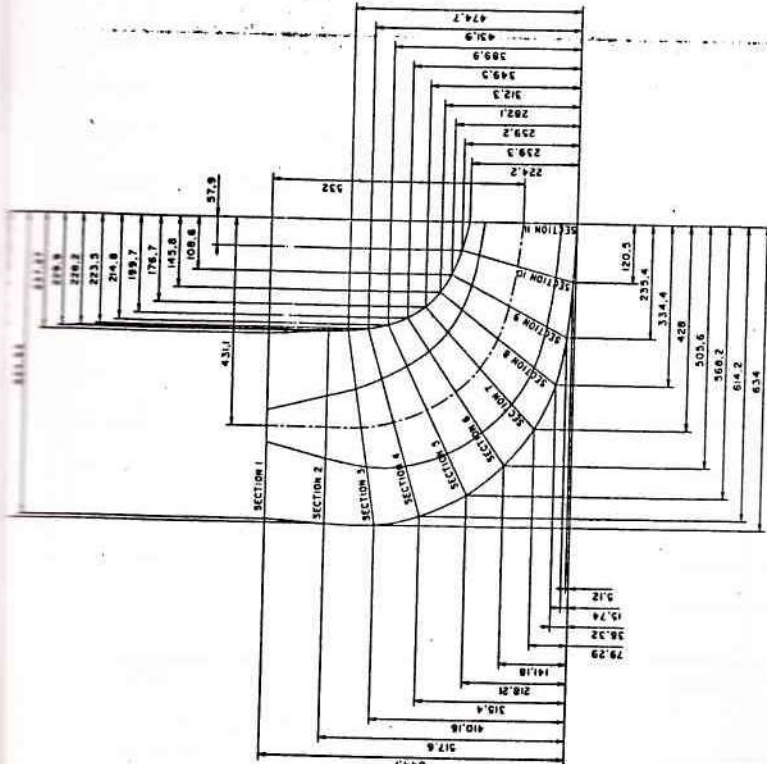
| Alpha_pale [deg] | Nbre de tours |
|------------------|---------------|
| 6                | 0 et 6/12     |
| 7                | 0 et 9/12     |
| 12.1             | 3 et 4/12     |
| 16               | 5 et 0/0      |
| 18               | 5 et 10/12    |
| 19               | 6 et 4/12     |
| 20               | 6 et 9/12     |
| 24               | 8 et 6/12     |
| 24.1             | 8 et 7/12     |
| 25               | 8 et 11/12    |
| 27               | 9 et 9/12     |
| 30.1             | 11 et 1/12    |
| 30.6             | 11 et 4/12    |
| 31.3             | 11 et 8/12    |
| 31.6             | 11 et 10/12   |
| 32               | 11 et 11/12   |
| 32.5             | 12 et 3/12    |
| 34               | 12 et 10/12   |
| 36               | 13 et 9/12    |

pour EDF

pour IMHEF

9/4/92





pour IMHET

G. Litty

pour EDF 12



**IMHEF**INSTITUT DE MACHINES HYDRAULIQUES  
ET DE MÉCANIQUE DES FLUIDES

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Contrôle du coude du diffuseur

Ecart entre le gabarit et le co

Essai:

328-00

GABRIEL TERRA

NEYRPIC

Date:

09 AVR 92

Page N°

Jeu

N°

[mm]

1

0,20

2

0,30

3

0,45

4

0,35

5

0,30

6

0,20

7

0,85

8

0,70

9

0,85

10

0,35

11

0,45

12

0,00

13

0,55

14

0,70

15

0,00

16

0,00

17

0,00

18

0,55

Observations

pour IMHEF

G. Lütj

pour EDF

12

pour NEYRPIC

pour UTE